The Department of Defense

DoD DEPARTMENTS:

Department of the Army

Department of the Navy

DARPA

Defense Advanced Research Projects Agency

Special Operations Command

OSD

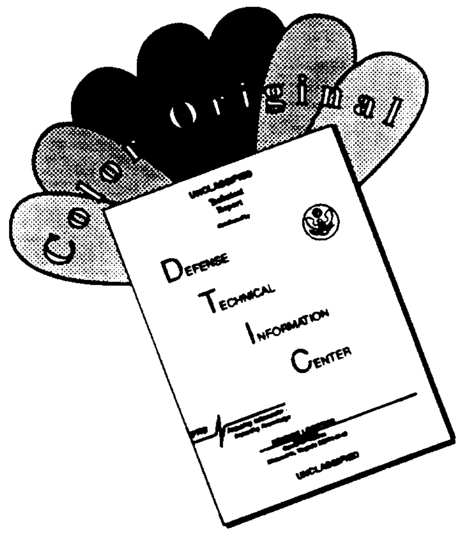
DDR&E

Office of Secretary of Defense Director Defense Research and Engineering

PROGRAM SOLICITATION 96.2
CLOSING DATE: 05 JULY 1996

FY 1996 SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM

DISCLAIMER NOTICE



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PROGRAM SOLICITATION

Number 96.2

Small Business Innovation Research Program

IMPORTANT

The DoD updates its SBIR mailing list annually. To remain on the mailing list or to be added to the list, send in the Mailing List form (Reference E), found at the back of this solicitation, to DTIC. Failure to send the form annually will result in removal of your name from the mailing list.

For general questions about the Defense Department's SBIR program, please call the SBIR/STTR Help Desk at (800) 382-4634.

U.S. Department of Defense
SBIR Program Office
Washington, DC 20301

Opening Date: MAY 1, 1996
Closing Date: JULY 5, 1996

Deadline for receipt of proposals at the DoD Component is 2:00 p.m. local time.

OFFICE OF THE UNDER SECRETARY OF DEFENSE

3000 DEFENSE PENTAGON
WASHINGTON DC 20301-3000

ACQUISITION AND TECHNOLOGY

IMPORTANT NEW FEATURES OF THE DEFENSE DEPARTMENT'S SBIR PROGRAM

This solicitation reflects a number of important changes in the Defense Department's SBIR program designed to (1) make the program more user-friendly to small firms and (2) increase commercialization of SBIR research in military and/or private sector markets. The main changes are summarized as follows:

1. Program assistance is as close as your telephone

Questions about proposal preparation? Contract negotiation? Government accounting requirements? Intellectual property protection? Financing strategy? Get help with these and other program-related information needs -- and save valuable time -- by contacting our new Department of Defense **SBIR/STTR Help Desk:**

- Phone: 800-382-4634 (8AM to 8PM EST)
- Fax: 800-462-4128
- Email: SBIRHELP@us.teltech.com

2. See our new SBIR/STTR Home Page (http://www.acq.osd.mil/sadbu/sbir)

Our new Home Page offers electronic access to model SBIR proposals and contracts, abstracts of recently-awarded SBIR projects, solicitations for the SBIR and Small Business Technology Transfer (STTR) programs, and other useful information.

3. New SBIR "Fast Track" for projects which obtain outside financing

The Department's SBIR program now features a fast-track SBIR process for companies which, during their Phase I projects, identify independent third-party investors that will match both Phase II SBIR funding and interim SBIR funding (between Phases I and II), in cash, at the matching rates described in Section 4.5. Companies which obtain such third-party investments and thereby qualify for the SBIR fast track will receive (subject to the qualifications described in Section 4.5): (1) interim SBIR funding between Phases I and II, (2) the Department's highest priority for Phase II funding, and (3) an expedited Phase II selection decision and award.

To enable potential third-party investors to identify Phase I projects in which to invest, the Department now electronically posts the abstracts of all selected Phase I awards on our SBIR Home Page, shortly after the awards are made.

4. Fewer delays in the SBIR process

All component SBIR programs within the Department are reducing the time interval between proposal receipt and award to an average of four months in Phase I and an average of six months in Phase II.

5. Opportunity to ask technical questions about solicitation topics

Approximately six weeks before each SBIR solicitation opens, the solicitation topics are pre-released electronically, on our Home Page, along with the names of topic authors or other technical experts and their phone numbers. This pre-release gives small companies an opportunity to ask technical questions about specific solicitation topics by telephone before the solicitation opens.

Once a solicitation opens, telephone questions will no longer be accepted, and companies may ask written questions through the SBIR Interactive Topic Information System (SITIS -- described in Section 7.2), in which the questioner and respondent remain anonymous and all questions and answers are posted electronically for general viewing. The SITIS service opens at the same time as the pre-release and closes to new questions approximately 30 days before the solicitation closes.

6. Other changes

- The Company Commercialization Report requirement has been modified to more accurately measure companies' success in commercializing previous SBIR projects (see Section 3.4(n)).
- Companies are now asked to briefly explain their commercialization strategies in their Phase I and Phase II proposals (see Section 3.4(h)).
- The Navy now accepts only electronic proposal submissions. See Section 8, page Navy-1.
- You are no longer required to submit red copies of the forms in appendices A through D, and may instead submit photocopies of these forms. However, please do not submit copies of these forms that have been downloaded from the Internet or from a computer disk (other than Navy's solicitation on disk), because the formatting will be lost. If you are reading an electronic version of this solicitation, you can obtain hard copies of these forms by calling 800/DoD-SBIR.
- The introduction to Section 8 contains guidance on how to obtain copies of the technical articles and military standards referenced in the solicitation topics (see p. 16).

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9.0 SUBMISSION FORMS AND CERTIFICATIONS

DoD PROGRAM SOLICITATION FOR SMALL BUSINESS INNOVATION RESEARCH

1.0 PROGRAM DESCRIPTION

1.1 Introduction

The Army, Navy, Defense Advanced Research Projects Agency (DARPA), Special Operations Command (SOCOM), and Office of Secretary of Defense Director of Defense Research and Engineering (OSD DDR&E), hereafter referred to as DoD Components, invite small business firms to submit proposals under this solicitation for the Small Business Innovation Research (SBIR) program. Firms with strong research and development capabilities in science or engineering in any of the topic areas described in Section 8.0 are encouraged to participate. Subject to availability of funds, DoD Components will support high quality research or research and development proposals of innovative concepts to solve the listed defense-related scientific or engineering problems, especially those concepts that also have high potential for commercialization in the private sector.

Objectives of the DoD SBIR Program include stimulating technological innovation, strengthening the role of small business in meeting DoD research and development needs, fostering and encouraging participation by minority and disadvantaged persons in technological innovation, and increasing the commercial application of DoD-supported research or research and development results.

The Federal SBIR Program is mandated by Public Laws PL 97-219, PL 99-443, and PL 102-564. The basic design of the DoD SBIR Program is in accordance with the Small Business Administration (SBA) SBIR Policy Directive, January 1993. The DoD Program presented in this solicitation strives to encourage scientific and technical innovation in areas specifically identified by DoD Components. The guidelines presented in this solicitation incorporate and exploit the flexibility of the SBA Policy Directive to encourage proposals based on scientific and technical approaches most likely to yield results important to DoD and the private sector.

1.2 Three Phase Program

This program solicitation is issued pursuant to the Small Business Innovation Development Act of 1982, PL 97-219, PL 99-443, and PL 102-564. Phase I is to determine, insofar as possible, the scientific, technical, and commercial merit and feasibility of ideas submitted under the SBIR Program. Phase I awards are typically up to $100,000 in size over a period not to exceed six months. Proposals should concentrate on that research or research and development which will significantly contribute to proving the scientific, technical, and commercial feasibility of the proposed effort, the successful completion of which is a prerequisite for further DoD support in Phase II. The measure of Phase I success includes evaluations of the extent to which Phase II results would have the potential to yield a product or process of continuing importance to DoD and the private sector. Proposers are encouraged to consider whether the research and development they are proposing to DoD Components also has private sector potential, either for the proposed application or as a base for other applications. If it appears to have such potential, proposers are encouraged, on an optional basis, to obtain a contingent commitment for private follow-on funding to pursue further development of the commercial potential after the government funded research and development phases.

Subsequent Phase II awards will be made to firms on the basis of results of their Phase I effort and the scientific, technical, and commercial merit of the Phase II proposal. Phase II awards are typically up to $750,000 in size over a period generally not to exceed 24 months (subject to negotiation). Phase II is the principal research or research and development effort and is expected to produce a well-defined deliverable product or process. A more comprehensive proposal will be required for Phase II.

Under Phase III, the small business is expected to use non-federal capital to pursue private sector applications of the research or development. Also, under Phase III, federal agencies may award non-SBIR funded follow-on contracts for products or processes which meet the mission needs of those agencies. This solicitation is designed, in part, to encourage the conversion of federally sponsored research and development innovation into private sector applications. The federal research and development can serve as both a technical and pre-venture capital base for ideas which may have commercial potential.

This solicitation is for Phase I proposals only. Only proposals submitted in response to this solicitation will considered for Phase I award. Offerors who were not awarded a contract in response to a prior SBIR solicitation are free to update or modify and re-submit the same or modified proposal if it is responsive to any of the topics listed in Section 8.0.

For Phase II, no separate solicitation will be issued and no unsolicited proposals will be accepted. Only those firms that were awarded Phase I contracts will be considered (Section 4.3 and 5.2).

DoD is not obligated to make any awards under either

Phase I, II, or III. DoD is not responsible for any monies expended by the proposer before award of any contract.

1.3 Follow-On Funding

In addition to supporting scientific and engineering research and development, another important goal of the program is conversion of DoD-supported research or research and development into commercial products. Proposers are encouraged to obtain a contingent commitment for private follow-on funding prior to Phase II where it is felt that the research or research and development has commercial potential in the private sector.

Proposers who feel that their research or research and development have the potential to meet private sector market needs, in addition to meeting DoD objectives, are encouraged to obtain non-federal follow-on funding for Phase III to pursue private sector development. The commitment should be obtained during the course of Phase I performance. This commitment may be contingent upon the DoD supported research or development meeting some specific technical objectives in Phase II which if met, would justify non-federal funding to pursue further development for commercial purposes in Phase III. *Note that when several Phase II proposals receive evaluations being of approximately equal merit, proposals that demonstrate such a commitment for follow-on funding will receive extra consideration during the evaluation process.*

The recipient will be permitted to obtain commercial rights to any invention made in either Phase I or Phase II, subject to the patent policies as stated in Section 5.7.

1.4 Eligibility and Limitation

Each proposer must qualify as a small business for research or research and development purposes as defined in Section 2.0 and certify to this on the Cover Sheet (Appendix A) of the proposal. In addition, a minimum of two-thirds of each Phase I SBIR project must be carried out by the proposing firm. For Phase II, a minimum of one-half of the effort must be performed by the proposing firm. For both Phase I and II, the primary employment of the principal investigator must be with the small business firm at the time of the award and during the conduct of the proposed effort. Primary employment means that more than one-half of the principal investigator's time is spent with the small business. Deviations from these requirements must be approved in writing by the contracting officer (during contract negotiations).

For both Phase I and Phase II, the research or research and development work must be performed by the small business concern in the United States. "United States" means the fifty states, the Territories and possessions of the United States, the Commonwealth of Puerto Rico, the Commonwealth of the Northern Mariana Islands, the Trust Territory of the Pacific Islands, and the District of Columbia.

Joint ventures and limited partnerships are permitted, provided that the entity created qualifies as a small business in accordance with the Small Business Act, 15 USC 631, and the definition included in Section 2.2.

1.5 Conflicts of Interest

Awards made to firms owned by or employing current or previous Federal Government employees could create conflicts of interest for those employees in violation of 18 USC and 10 USC 2397. Such proposers should contact the cognizant Ethics Counselor of the DoD Component for further guidance.

1.6 Contact with DoD

a. General Information. General information questions pertaining to proposal instructions contained in this solicitation should be directed to the SBIR/STTR Help Desk at (800) 382-4634.

Other non-technical questions pertaining to a specific DoD Component should be directed in accordance with instructions given at the beginning of that DoD Component's topics in Section 8.0 of this solicitation. Oral communications with DoD Components regarding the technical content of this solicitation during the Phase I proposal preparation periods are prohibited for reasons of competitive fairness.

b. Requests for Copies of DoD SBIR Solicitation. *To remain on the DoD SBIR Mailing list, send in the Mailing List form (Reference E) to DTIC.* Additional copies of this solicitation may be ordered from:

Defense Technical Information Center
Attn: DTIC/SBIR
8725 John J Kingman Rd, Suite 0944
Ft. Belvoir, VA 22060-6218
(800) 363-7247 (800 DOD-SBIR)

This solicitation is also available on floppy diskette (in Word Perfect) from DTIC for a nominal processing fee. DoD SBIR and STTR solicitations can be access via Internet through DTIC and NTTC.

DTIC	www	http://www.dtic.dla.mil/dtic/sbir/
	gopher	gopher.dtic.dla.mil
	ftp	asc.dtic.dla.mil
NTTC	www	http://www.nttc.edu/solicitations.html
	ftp/telnet	iron.nttc.edu

It can also be obtained electronically using Business Gold, the National Technology Transfer Center's bulletin board

system. Connect by dialing (304) 243-2560 for high speed modems (9600+) or (304) 243-2561 for 1200-2400 baud modems and logging in as guest. For more information on the NTTC electronic bulletin board system contact:

National Technology Transfer Center
Wheeling Jesuit College
316 Washington Ave
Wheeling, WV 26003
(800) 678-6882

c. Outreach Program. The DoD holds three National SBIR Conferences a year and participates in many state-organized conferences for small business. We have a special outreach effort to socially and economically and disadvantaged firms and to small companies that are negatively affected by the Defense down-sizing.

2.0 DEFINITIONS

The following definitions apply for the purposes of this solicitation:

2.1 Research or Research and Development

Basic Research - Scientific study and experimentation to provide fundamental knowledge required for the solution of problems.

Exploratory Development - A study, investigation or minor development effort directed toward specific problem areas with a view toward developing and evaluating the feasibility and practicability of proposed solutions.

Advanced Development - Proof of design efforts directed toward projects that have moved into the development of hardware for test.

Engineering Development - Full-scale engineering development projects for DoD use but which have not yet received approval for production.

2.2 Small Business

A small business concern is one that, at the time of award of a Phase I or Phase II contract:

a. Is independently owned and operated and organized for profit, is not dominant in the field of operation in which it is proposing, and has its principal place of business located in the United States;

b. Is at least 51% owned, or in the case of a publicly owned business, at least 51% of its voting stock is owned by United States citizens or lawfully admitted permanent resident aliens;

c. Has, including its affiliates, a number of employees not exceeding 500, and meets the other regulatory requirements found in 13 CFR 121. Business concerns, other than investment companies licensed, or state development companies qualifying under the Small Business Investment Act of 1958, 15 USC 661, et seq., are affiliates of one another when either directly or indirectly (1) one concern controls or has the power to control the other; or (2) a third party or parties controls or has the power to control both. Control can be exercised through common ownership, common management, and contractual relationships. The term "affiliates" is defined in greater detail in 13 CFR 121.3-2(a). The term "number of employees" is defined in 13 CFR 121.3-2(t). Business concerns include, but are not limited to, any individual, partnership, corporation, joint venture, association or cooperative.

2.3 Socially and Economically Disadvantaged Small Business

A small business that is at the time of award of a Phase I or Phase II contract:

a. At least 51% owned by an Indian tribe or a native Hawaiian organization, or one or more socially and economically disadvantaged individuals, and

b. Whose management and daily business operations are controlled by one or more socially and economically disadvantaged individuals.

A socially and economically disadvantaged individual is defined as a member of any of the following groups: Black Americans, Hispanic Americans, Native Americans, Asian-Pacific Americans, Subcontinent-Asian Americans, or other groups designated by SBA to be socially disadvantaged.

2.4 Women-Owned Small Business

A women-owned small business is one that is at least 51% owned by a woman or women who also control and operate it. "Control" in this context means exercising the power to make policy decisions. "Operate" in this context means being actively involved in the day-to-day management.

2.5 Funding Agreement

Any contract, grant, or cooperative agreement entered into between any federal agency and any small business concern for the performance of experimental, developmental, or research work funded in whole or in part by the federal government. *Only the contract method will be used by DoD components for all SBIR awards.*

2.6 Subcontract

A subcontract is any agreement, other than one involving an employer-employee relationship, entered into by a Federal Government contract awardee calling for supplies or services required solely for the performance of the original contract. This includes consultants.

2.7 Commercialization

The process of developing markets and producing and delivering products for sale (whether by the originating party or by others); as used here, commercialization includes both government and private sector markets.

3.0 PROPOSAL PREPARATION INSTRUCTIONS AND REQUIREMENTS

3.1 Proposal Requirements

A proposal to any DoD Component under the SBIR Program is to provide sufficient information to persuade the DoD Component that the proposed work represents an innovative approach to the investigation of an important scientific or engineering problem and is worthy of support under the stated criteria.

The quality of the scientific or technical content of the proposal will be the principal basis upon which proposals will be evaluated. The proposed research or research and development must be responsive to the chosen topic. Any small business contemplating a bid for work on any specific topic should determine that (a) the technical approach has a reasonable chance of meeting the topic objective, (b) this approach is innovative, not routine, and (c) the firm has the capability to implement the technical approach, i.e. has or can obtain people and equipment suitable to the task.

Those responding to this solicitation should note the proposal preparation tips listed below:

- Read and follow all instructions contained in this solicitation.
- Use the free technical information services from DTIC and other information assistance organizations (Section 7.1 - 7.4).
- Mark proprietary information as instructed in Section 5.5.
- Limit your proposal to 25 pages (excluding company commercialization report).
- Use a type size no smaller than 12 pitch or 11 point.
- Don't include proprietary or classified information in the project summary (Appendix B).
- Include a copy of Appendix A and Appendix B as part of the original of each proposal.
- Do not use a proportionally spaced font on Appendix A and Appendix B.
- Include a company commercialization report, where required, listing all SBIR Phase I and Phase II projects and the commercialization status of Phase II projects (see details in Section 3.4.n).

3.2 Proprietary Information

If information is provided which constitutes a trade secret, proprietary, commercial or financial information, confidential personal information, or data affecting the national security, it will be treated in confidence to the extent permitted by law, provided it is clearly marked in accordance with Section 5.5.

3.3 Limitations on Length of Proposal

This solicitation is designed to reduce the investment of time and cost to small firms in preparing a formal proposal. Those who wish to respond must submit a direct, concise, and informative research or research and development proposal of no more than 25 pages, excluding commercialization record summary, (no type smaller than 11 point or 12 pitch on standard 8½" X 11" paper with one (1) inch margins, 6 lines per inch), *including Proposal Cover Sheet (Appendix A), Project Summary (Appendix B), Cost Proposal (Appendix C), and any enclosures or attachments.* Promotional and non-project related discussion is discouraged. Cover all items listed below in Section 3.4 in the order given. The space allocated to each will depend on the problem chosen and the principal investigator's approach. In the interest of equity, proposals in excess of the 25-page limitation (including attachments, appendices, or references, but excluding commercialization record summary) <u>will not</u> be considered for review or award.

3.4 Phase I Proposal Format

All pages shall be consecutively numbered and the ORIGINAL of each proposal must contain a completed copy of Appendix A and Appendix B.

a. Cover Sheet. Complete Appendix A, photocopy the completed form, and use a copy as Page 1 of each additional copy of your proposal.

b. Project Summary. Complete Appendix B, photocopy the completed form, and use a copy as Page 2 of each additional copy of your proposal. The technical abstract should include a brief description of the project objectives and description of the effort. Anticipated benefits and commercial applications of the proposed research or research and development should also be summarized in the space provided. The Project Summaries of proposals selected for award will be publicly released on the Internet and, therefore, should not contain proprietary or classified information.

c. Identification and Significance of the Problem or Opportunity. Define the specific technical problem or opportunity addressed and its importance. (Begin on Page 3 of your proposal.)

d. Phase I Technical Objectives. Enumerate the specific objectives of the Phase I work, including the questions it will try to answer to determine the feasibility of the proposed approach.

e. Phase I Work Plan. Provide an explicit, detailed description of the Phase I approach. The plan should indicate what is planned, how and where the work will be carried out, a schedule of major events, and the final product to be delivered. Phase I effort should attempt to determine the technical feasibility of the proposed concept. The methods planned to achieve each objective or task should be discussed explicitly and in detail. This section should be a substantial portion of the total proposal.

f. Related Work. Describe significant activities directly related to the proposed effort, including any conducted by the principal investigator, the proposing firm, consultants, or others. Describe how these activities interface with the proposed project and discuss any planned coordination with outside sources. The proposal must persuade reviewers of the proposer's awareness of the state-of-the-art in the specific topic.

Describe previous work not directly related to the proposed effort but similar. Provide the following: (1) short description, (2) client for which work was performed (including individual to be contacted and phone number), and (3) date of completion.

g. Relationship with Future Research or Research and Development.

(1) State the anticipated results of the proposed approach if the project is successful.
(2) Discuss the significance of the Phase I effort in providing a foundation for Phase II research or research and development effort.

h. Potential Post Applications. Describe, in approximately one page, your company's strategy for converting your proposed SBIR research into a product or products with widespread commercial use in private sector and/or military markets.

i. Key Personnel. Identify key personnel who will be involved in the Phase I effort including information on directly related education and experience. A concise resume of the principal investigator, including a list of relevant publications (if any), must be included.

j. Facilities/Equipment. Describe available instrumentation and physical facilities necessary to carry out the Phase I effort. Items of equipment to be purchased (as detailed in Appendix C) shall be justified under this section. Also state whether or not the facilities where the proposed work will be performed meet environmental laws and regulations of federal, state (name) and local governments for, but not limited to, the following groupings: airborne emissions, waterborne effluents, external radiation levels, outdoor noise, solid and bulk waste disposal practices, and handling and storage of toxic and hazardous materials.

k. Consultants. Involvement of university or other consultants in the project may be appropriate. If such involvement is intended, it should be described in detail and identified in Appendix C. A minimum of two-thirds of each Phase I SBIR project must be carried out by the proposing firm, unless otherwise approved in writing by the contracting officer.

l. Prior, Current, or Pending Support of Similar Proposals or Awards. *Warning* -- While it is permissible, with proposal notification, to submit identical proposals or proposals containing a significant amount of essentially equivalent work for consideration under numerous federal program solicitations, it is unlawful to enter into contracts or grants requiring essentially equivalent effort. If there is any question concerning this, it must be disclosed to the solicitating agency or agencies before award.

If a proposal submitted in response to this solicitation is substantially the same as another proposal that has been funded, is now being funded, or is pending with another federal agency or DoD Component or the same DoD Component, the proposer must indicate action on Appendix A and provide the following information:

(1) Name and address of the federal agency(s) or DoD Component to which a proposal was submitted, will be submitted, or from which an award is expected or has been received.
(2) Date of proposal submission or date of award.
(3) Title of proposal.

(4) Name and title of principal investigator for each proposal submitted or award received.
(5) Title, number, and date of solicitation(s) under which the proposal was submitted, will be submitted, or under which award is expected or has been received.
(6) If award was received, state contract number.
(7) Specify the applicable topics for each SBIR proposal submitted or award received.

Note: If Section 3.4.1 does not apply, state in the proposal "No prior, current, or pending support for proposed work."

m. Cost Proposal. Complete the cost proposal in the form of Appendix C for the Phase I effort only. Some items of Appendix C may not apply to the proposed project. If such is the case, there is no need to provide information on each and every item. What matters is that enough information be provided to allow the DoD Component to understand how the proposer plans to use the requested funds if the contract is awarded.

(1) List all key personnel by <u>name</u> as well as by number of <u>hours</u> dedicated to the project as direct labor.
(2) Special tooling and test equipment and material cost may be included under Phases I and II. The inclusion of equipment and material will be carefully reviewed relative to need and appropriateness for the work proposed. The purchase of special tooling and test equipment must, in the opinion of the Contracting Officer, be advantageous to the government and should be related directly to the specific topic. These may include such items as innovative instrumentation and/or automatic test equipment. Title to property furnished by the government or acquired with government funds will be vested with the DoD Component, unless it is determined that transfer of title to the contractor would be more cost effective than recovery of the equipment by the DoD Component.
(3) Cost for travel funds must be justified and related to the needs of the project.
(4) Cost sharing is permitted for proposals under this solicitation; however, cost sharing is not required nor will it be an evaluation factor in the consideration of a Phase I proposal.

n. Company Commercialization Report on Prior SBIR Awards. For Phase I proposals, if the small business concern has received more than 15 Phase II awards in the prior 5 fiscal years, it must submit a brief report on the small business concern's activity in commercializing previous SBIR (or STTR) research projects, using the following format:

(1) list the name of awarding federal agency, date of award, contract number, topic or subtopic, title, and award amount for each Phase I and Phase II project, and
(2) list, for each Phase II project,
    (a) the sources and amounts of non-SBIR/non-STTR funding received for Phase III, and
    (b) the revenue from sales of new products in Phase III.

    Apportion the Phase III funding and sales revenue among the various Phase II projects without double-counting.

<u>All</u> Phase II proposals must include a Company Commercialization Report in this format. (This required proposal information shall not be counted toward proposal pages count limitations.)

3.5 Bindings

Do not use special bindings or cover. Staple the pages in the upper left hand corner of each proposal.

3.6 Phase II Proposal

This solicitation is for Phase I only. A Phase II proposal can be submitted only by a Phase I awardee and only in response to a request from the agency; that is, Phase II is not initiated by a solicitation. Each proposal must contain a Cover Sheet (Appendix A), a Project Summary Sheet (Appendix B), and a Company Commercialization Report (see Section 3.4.n) regardless of the number of Phase II awards received. <u>Copies of Appendices along with instructions regarding Phase II proposal preparation and submission will be provided by the DoD Components to all Phase I winners at time of Phase I contract award.</u>

4.0 METHOD OF SELECTION AND EVALUATION CRITERIA

4.1 Introduction

Phase I proposals will be evaluated on a competitive basis and will be considered to be binding for six (6) months from the date of closing of this solicitation unless offeror states otherwise. If selection has not been made prior to the proposal's expiration date, offerors will be requested as to whether or not they want to extend their proposal for an additional period of time. Proposals meeting stated solicitation requirements will be evaluated by scientists or engineers knowledgeable in the topic area. <u>Proposals will be evaluated first on their relevance to the chosen topic.</u> Those found to be relevant will then be evaluated using the criteria listed in Section 4.2. Final decisions will be made by the DoD Component based upon these criteria and consideration of other factors including

possible duplication of other work, and program balance. A DoD Component may elect to fund several or none of the proposed approaches to the same topic. In the evaluation and handling of proposals, every effort will be made to protect the confidentiality of the proposal and any evaluations. There is no commitment by the DoD Components to make any awards on any topic, to make a specific number of awards or to be responsible for any monies expended by the proposer before award of a contract.

For proposals that have been selected for contract award, a Government Contracting Officer will draw up an appropriate contract to be signed by both parties before work begins. Any negotiations that may be necessary will be conducted between the offeror and the Government Contracting Officer. It should be noted that only a duly appointed contracting officer has the authority to enter into a contract on behalf of the U.S. Government.

Phase II proposals will be subject to a technical review process similar to Phase I. Final decisions will be made by DoD Components based upon the scientific and technical evaluations and other factors, including a commitment for Phase III follow-on funding, the possible duplication with other research or research and development, program balance, budget limitations, and the potential of a successful Phase II effort leading to a product of continuing interest to DoD.

Upon written request and after final award decisions have been announced, a debriefing will be provided to unsuccessful offerors on their proposals.

4.2 Evaluation Criteria - Phase I

The DoD Components plan to select for award those proposals offering the best value to the government and the nation considering the following factors.

a. The soundness and technical merit of the proposed approach and its incremental progress toward topic or subtopic solution

b. The potential for commercial (government or private sector) application and the benefits expected to accrue from this commercialization

c. The adequacy of the proposed effort for the fulfillment of requirements of the research topic

d. The qualifications of the proposed principal/key investigators supporting staff and consultants. Qualifications include not only the ability to perform the research and development but also the ability to commercialize the results.

Where technical evaluations are essentially equal in merit, cost to the government will be considered in determining the successful offeror.

Technical reviewers will base their conclusions only on information contained in the proposal. It cannot be assumed that reviewers are acquainted with the firm or key individuals or any referenced experiments. Relevant supporting data such as journal articles, literature, including government publications, etc., should be contained or referenced in the proposal.

4.3 Evaluation Criteria - Phase II

The Phase II proposal will be reviewed for overall merit based upon the criteria below.

a. The soundness and technical merit of the proposed approach and its incremental progress toward topic or subtopic solution

b. The potential for commercial (government or private sector) application and the benefits expected to accrue from this commercialization

c. The adequacy of the proposed effort for the fulfillment of requirements of the research topic

d. The qualifications of the proposed principal/key investigators supporting staff and consultants. Qualifications include not only the ability to perform the research and development but also the ability to commercialize the results.

The reasonableness of the proposed costs of the effort to be performed will be examined to determine those proposals that offer the best value to the government. Where technical evaluations are essentially equal in merit, cost to the government will be considered in determining the successful offeror.

The follow-on funding commitment must provide that a specific amount of Phase III funds will be made available to or by the small business and indicate the dates the funds will be made available. It must also contain specific technical objectives which, if achieved in Phase II, will make the commitment exercisable by the small business. The terms cannot be contingent upon the obtaining of a patent due to the length of time this process requires. The funding commitment shall be submitted with the Phase II proposal.

Phase II proposal evaluation may include on-site evaluations of the Phase I effort by government personnel.

4.4 Assessing Commercial Potential of Proposals

A Phase I or Phase II proposal's commercial potential can be evidenced by:

(1) the small business concern's record of commercializing SBIR or other research (see Company Commercialization Report, Section 3.4.n),

(2) the existence of second phase funding commitments from private sector or non-SBIR funding sources,

(3) the existence of third phase follow-on commitments for the subject of the research, or

(4) the presence of other indicators of commercial potential of the idea.

4.5 SBIR Fast Track

a. In General. On a two-year pilot basis, beginning with this solicitation, the DoD SBIR program will implement a fast-track SBIR process for companies which, during their Phase I projects, attract independent third-party investors that will match both phase II SBIR funding and interim SBIR funding (between Phases I and II). As discussed in detail below, companies which obtain such third-party matching funds and thereby qualify for the SBIR fast track will receive (subject to the qualifications described herein):

(1) Interim funding on the order of $40,000 (generally, $30,000 to $50,000) between Phases I and II;

(2) The Department's highest priority for Phase II SBIR funding; and

(3) An expedited Phase II selection decision and, upon selection, an expedited Phase II award.

b. How To Qualify for the SBIR Fast Track. To qualify for the SBIR fast track, a company must submit the following items, within 120 days after the start of its Phase I project, to the same address the company would send its Phase II proposal (see back of Appendix D):

(1) A completed fast-track application form, found at Appendix D. (Please also send a copy to OSD SBIR -- see back of Appendix D.)

(2) A commitment letter from an independent third-party investor -- such as another company, a venture capital firm, an "angel" investor, or a non-SBIR government program -- indicating that the third-party investor will match both interim and Phase II SBIR funding, in cash, contingent upon the company's receipt of interim and Phase II SBIR funds.

The matching rates are as follows:

(a) For companies that have 10 or fewer employees and have never received a Phase II SBIR award from DoD or any other federal agency, the minimum matching rate is 25 cents for every SBIR dollar. (For example, if such a company receives an interim SBIR award of $40,000 and a Phase II award of $750,000, it must obtain matching funds of $10,000 and $187,500 respectively for the two awards.)

(b) For companies that have received 5 or more Phase II SBIR awards from the federal government (including DoD), the minimum matching rate is 1 dollar for every SBIR dollar. (For example, if such a company receives an interim SBIR award of $40,000 and a Phase II award of $750,000, it must obtain matching funds of $40,000 and $750,000 respectively for the two awards.)

(c) For all other companies, the minimum matching rate is 50 cents for every SBIR dollar. (For example, if such a company receives an interim SBIR award of $40,000 and a Phase II award of $750,000, it must obtain matching funds of $20,000 and $375,000 respectively for the two awards.)

The commitment letter should indicate that the third-party funds will pay for work that is connected to the particular SBIR project, and should describe the general nature of that work. The work funded by the third-party investor may be additional research and development on the project or, alternatively, it may be other activity related to the project (e.g., marketing) that is outside the scope of the SBIR contract.

(3) A concise statement of work for the interim SBIR effort (if an interim option was not previously negotiated on the Phase I contract). This statement of work should be under 4 pages in length.

(4) A concise report on the status of the Phase I project, if required by the DoD component that is funding the project. This report should be under 4 pages in length.

In addition:

(1) The company must submit its Phase II proposal no later than 30 days prior to completion of its Phase I project, unless a different deadline for fast-track Phase II proposals is specified in the Phase II proposal instructions of the sponsoring DoD component.

(2) If the company receives an interim and/or Phase II SBIR award from DoD, its matching funds must arrive before corresponding installments of SBIR funds are released. For example, a company whose matching rate is 50 cents to the dollar must certify, to the satisfaction of its DoD contracting officer, that it has received $20,000 in cash from the third-party investor before the contracting officer will release $40,000 in interim SBIR funds. Similarly, the company must certify that it has received $30,000 in third-party funds before the contracting officer will release a $60,000 installment of phase II funds. (A simple letter stating that the third-party funds have arrived, with an attached copy of the bank statement, should generally suffice.)

Failure to meet these conditions in their entirety and within the time frames indicated will disqualify a company from participation in the SBIR fast track. The company will still be eligible to compete for a Phase II SBIR award through the regular procedures.

c. Benefits of Qualifying for the Fast Track. A company which qualifies for the fast track will:

(1) Receive interim SBIR funding on the order of $40,000 (generally, $30,000 to $50,000), commencing at the end of Phase I.

Note: It is DoD policy that the vast majority of Phase I contracts which qualify for the fast track will receive interim SBIR funding. However, the DoD contracting office has the discretion and authority, in any particular instance, to deny interim funding to a Phase I contractor when doing so is in the government's interest (e.g., when the project no longer meets a military need).

(2) Receive the Department's highest priority for Phase II award. Specifically, it is DoD policy that the percentage of fast-track Phase I projects which receive Phase II awards will be significantly higher than the overall percentage of Phase I projects which receive Phase II awards. (Historically, roughly one-third of Phase I projects at DoD receive Phase II awards.)

(3) Receive notification of whether it has been selected for a Phase II award, within an average of two months -- and, in all cases, no longer than ten weeks -- after the completion of its Phase I project.

(4) If selected, receive its Phase II award within an average of five months from the completion of its Phase I project.

5.0 CONTRACTUAL CONSIDERATIONS

Note: Eligibility and Limitation Requirements (Section 1.4) Will Be Enforced

5.1 Awards (Phase I)

a. Number of Phase I Awards. The number of Phase I awards will be consistent with the agency's RDT&E budget, the number of anticipated awards for interim Phase I modifications, and the number of anticipated Phase II contracts. No Phase I contracts will be awarded until all qualified proposals (received in accordance with Section 6.2) on a specific topic have been evaluated. All proposers will be notified of selection/non-selection status for a Phase I award no later than November 5, 1996. The name of those firms selected for awards will be announced. *The DoD Components anticipate making 460 Phase I awards from this solicitation.* On average, 1 in 8 Phase I proposals receive funding.

b. Type of Funding Agreement. All winning proposals will be funded under negotiated contracts and may include a fee or profit. The firm fixed price or cost plus fixed fee type contract will be used for all Phase I projects (see Section 5.4). *Note: The firm fixed price contract is the preferred type for Phase I.*

c. Average Dollar Value of Awards. DoD Components will make Phase I awards to small businesses typically on a one-half person-year effort over a period generally not to exceed six months (subject to negotiation). PL 102-564 allows agencies to award Phase I contracts up to $100,000 without justification. Where applicable, specific funding instructions are contained in Section 8 for each DoD Component.

5.2 Awards (Phase II)

a. Number of Phase II Awards. The number of Phase II awards will depend upon the results of the Phase I efforts and the availability of funds. *The DoD Components anticipate that approximately 40 percent of its Phase I awards will result in Phase II projects.*

b. Type of Funding Agreement. Each Phase II proposal selected for award will be funded under a negotiated contract and may include a fee or profit.

c. Project Continuity. Phase II proposers who wish to maintain project continuity must submit proposals no later than 30 days prior to the expiration date of the Phase I contract and must identify in their proposal the work to be performed for the first four months of the Phase II effort and the costs associated therewith. *These Phase II proposers may be issued a modification to the Phase I contract, at the discretion of the government*, covering an interim period not to exceed four months for preliminary Phase II work while the total Phase II proposal is being evaluated and a contract is negotiated. This modification would normally become effective at the completion of Phase I or as soon thereafter as possible. Funding, scope of work, and length of performance for this interim period will be subject to negotiations. Issuance of a contract modification for the interim period does not commit the government to award a Phase II contract. See special instructions for each DoD Component in Section 8. *(For Phase I projects which qualify for the SBIR Fast Track, the*

instructions in Section 4.5 supersede those in this paragraph.)

d. Average Dollar Value of Awards. Phase II awards will be made to small businesses based on results of the Phase I efforts and the scientific, technical, and commercial merit of the Phase II proposal. Average Phase II awards will typically cover 2 to 5 person-years of effort over a period generally not to exceed 24 months (subject to negotiation). PL 102-564 states that the Phase II awards may be up to $750,000 each without justification. See special instructions for each DoD Component in Section 8.

5.3 Reports

a. Content. A final report is required for each Phase I project. The report must contain in detail the project objectives, work performed, results obtained, and estimates of technical feasibility. A completed SF 298, "Report Documentation Page", will be used as the first page of the report. In addition, Monthly status and progress reports may be required by the DoD agency. (A blank SF 298 is provided in Section 9.0, Reference D.)

b. Preparation.

(1) To avoid duplication of effort, language used to report Phase I progress in a Phase II proposal, if submitted, may be used verbatim in the final report with changes to accommodate results after Phase II proposal submission and modifications required to integrate the final report into a self-contained comprehensive and logically structured document.

(2) Block 12a (Distribution/Availability Statement) of the SF298, "Report Documentation Page" in each unclassified final report must contain one of the following statements:
   (a) Approved for public release; distribution unlimited.
   (b) Distribution authorized to U.S. Government Agencies only; contains proprietary information.

(3) Block 13 (Abstract) of the SF 298, "Report Documentation Page") must include as the first sentence, "Report developed under SBIR contract". The abstract must identify the purpose of the work and briefly describe the work carried out, the finding or results and the potential applications of the effort. Since the abstract will be published by the DoD, it must not contain any proprietary or classified data.

(4) Block 14 (Subject Terms) of the SF 298 must include the term "SBIR Report".

c. Submission. SIX COPIES of the final report on each Phase I project shall be submitted to the DoD in accordance with the negotiated delivery schedule. Delivery will normally be within thirty days after completion of the Phase I technical effort. One copy of each unclassified report shall be delivered directly to the DTIC, ATTN: Document Acquisition, 8725 John J Kingman Road, Suite 0944, Ft. Belvoir, VA 22060-6218.

5.4 Payment Schedule

The specific payment schedule (including payment amounts) for each contract will be incorporated into the contract upon completion of negotiations between the DoD and the successful Phase I or Phase II offeror. Successful offerors may be paid periodically as work progresses in accordance with the negotiated price and payment schedule. Phase I contracts are primarily fixed price contracts, under which monthly progress payments may be made up to 90% of the contract price excluding fee or profit. The contract may include a separate provision for payment of a fee or profit. Final payment will follow completion of contract performance and acceptance of all work required under the contract. Other types of financial assistance may be available under the contract.

5.5 Markings of Proprietary or Classified Proposal Information

The proposal submitted in response to this solicitation may contain technical and other data which the proposer does not want disclosed to the public or used by the government for any purpose other than proposal evaluation.

Information contained in unsuccessful proposals will remain the property of the proposer except for Appendices A and B. The government may, however, retain copies of all proposals. Public release of information in any proposal submitted will be subject to existing statutory and regulatory requirements.

If proprietary information is provided by a proposer in a proposal which constitutes a trade secret, proprietary commercial or financial information, confidential personal information or data affecting the national security, it will be treated in confidence, to the extent permitted by law, provided this information is clearly marked by the proposer with the term "confidential proprietary information" and provided that the following legend which appears on the title page (Appendix A) of the proposal is completed:

> "For any purpose other than to evaluate the proposal, this data except Appendix A and B shall not be disclosed outside the government and shall not be duplicated, used, or disclosed in whole or in part, provided that if a contract is awarded to the proposer as a result of or in connection with the submission of this data, the government shall have the right to duplicate, use or disclose the data to the extent provided in the contract. This restriction does not limit the government's right to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained in

page(s)________of this proposal."

Any other legend may be unacceptable to the government and may constitute grounds for removing the proposal from further consideration and without assuming any liability for inadvertent disclosure. The government will limit dissemination of properly marked information to within official channels.

In addition, each page of the proposal containing proprietary data which the proposer wishes to restrict must be marked with the following legend:

"Use or disclosure of the proposal data on lines specifically identified by asterisk (*) are subject to the restriction on the cover page of this proposal."

The government assumes no liability for disclosure or use of unmarked data and may use or disclose such data for any purpose.

In the event properly marked data contained in a proposal in response to this solicitation is requested pursuant to the Freedom of Information Act, 5 USC 552, the proposer will be advised of such request and prior to such release of information will be requested to expeditiously submit to the DoD Component a detailed listing of all information in the proposal which the proposer believes to be exempt from disclosure under the Act. Such action and cooperation on the part of the proposer will ensure that any information released by the DoD Component pursuant to the Act is properly determined.

Those proposers that have a classified facility clearance may submit classified material with their proposal. Any classified material shall be marked and handled in accordance with applicable regulations. Arbitrary and unwarranted use of this restriction is discouraged. Offerors must follow the Industrial Security Manual for Safeguarding Classified Information (DoD 5220.22M) procedures for marking and handling classified material.

5.6 Copyrights

To the extent permitted by statute, the awardee may copyright (consistent with appropriate national security considerations, if any) material developed with DoD support. DoD receives a royalty-free license for the Federal Government and requires that each publication contain an appropriate acknowledgement and disclaimer statement.

5.7 Patents

Small business firms normally may retain the principal worldwide patent rights to any invention developed with government support. The government receives a royalty-free license for its use, reserves the right to require the patent holder to license others in certain limited circumstances, and requires that anyone exclusively licensed to sell the invention in the United States must normally manufacture it domestically. To the extent authorized by 35 USC 205, the government will not make public any information disclosing a government-supported invention for a period of five years to allow the awardee to pursue a patent.

5.8 Technical Data Rights

Rights in technical data, including software, developed under the terms of any contract resulting from proposals submitted in response to this solicitation generally remain with the contractor, except that the government obtains a royalty-free license to use such technical data only for government purposes during the period commencing with contract award and ending five years after completion of the project under which the data were generated. Upon expiration of the five-year restrictive license, the government has unlimited rights in the SBIR data. During the license period, the government may not release or disclose SBIR data to any person other than its support services contractors except: (1) For evaluational purposes; (2) As expressly permitted by the contractor; or (3) A use, release, or disclosure that is necessary for emergency repair or overhaul of items operated by the government. See FAR clause 52.227-20, "Rights in Data - SBIR Program" and DFARS 252.227-7018, "Rights in Noncommercial Technical Data and Computer Software -- SBIR Program."

5.9 Cost Sharing

Cost sharing is permitted for proposals under this solicitation; however, cost sharing is not required nor will it be an evaluation factor in the consideration of any Phase I proposal.

5.10 Joint Ventures or Limited Partnerships

Joint ventures and limited partnerships are eligible provided the entity created qualifies as a small business as defined in Section 2.2 of this solicitation.

5.11 Research and Analytical Work

a. For Phase I a minimum of two-thirds of the research and/or analytical effort must be performed by the proposing firm unless otherwise approved in writing by the contracting officer.

b. For Phase II a minimum of one-half of the research and/or analytical effort must be performed by the proposing firm, unless otherwise approved in writing by the contracting officer.

5.12 Contractor Commitments

Upon award of a contract, the contractor will be required to make certain legal commitments through acceptance of government contract clauses in the Phase I contract. The outline that follows is illustrative of the types of provisions required by the Federal Acquisition Regulations that will be included in the Phase I contract. This is not a complete list of provisions to be included in Phase I contracts, nor does it contain specific wording of these clauses. Copies of complete general provisions will be made available prior to award.

a. Standards of Work. Work performed under the contract must conform to high professional standards.

b. Inspection. Work performed under the contract is subject to government inspection and evaluation at all reasonable times.

c. Examination of Records. The Comptroller General (or a fully authorized representative) shall have the right to examine any directly pertinent records of the contractor involving transactions related to this contract.

d. Default. The government may terminate the contract if the contractor fails to perform the work contracted.

e. Termination for Convenience. The contract may be terminated at any time by the government if it deems termination to be in its best interest, in which case the contractor will be compensated for work performed and for reasonable termination costs.

f. Disputes. Any dispute concerning the contract which cannot be resolved by agreement shall be decided by the contracting officer with right of appeal.

g. Contract Work Hours. The contractor may not require an employee to work more than eight hours a day or forty hours a week unless the employee is compensated accordingly (that is, receives overtime pay).

h. Equal Opportunity. The contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin.

i. Affirmative Action for Veterans. The contractor will not discriminate against any employee or applicant for employment because he or she is a disabled veteran or veteran of the Vietnam era.

j. Affirmative Action for Handicapped. The contractor will not discriminate against any employee or applicant for employment because he or she is physically or mentally handicapped.

k. Officials Not to Benefit. No member of or delegate to Congress shall benefit from the contract.

l. Covenant Against Contingent Fees. No person or agency has been employed to solicit or secure the contract upon an understanding for compensation except bona fide employees or commercial agencies maintained by the contractor for the purpose of securing business.

m. Gratuities. The contract may be terminated by the government if any gratuities have been offered to any representative of the government to secure the contract.

n. Patent Infringement. The contractor shall report each notice or claim of patent infringement based on the performance of the contract.

o. Military Security Requirements. The contractor shall safeguard any classified information associated with the contracted work in accordance with applicable regulations.

p. American Made Equipment and Products. When purchasing equipment or a product under the SBIR funding agreement, purchase only American-made items whenever possible.

5.13 Additional Information

a. General. This Program Solicitation is intended for information purposes and reflects current planning. If there is any inconsistency between the information contained herein and the terms of any resulting SBIR contract, the terms of the contract are controlling.

b. Small Business Data. Before award of an SBIR contract, the government may request the proposer to submit certain organizational, management, personnel, and financial information to confirm responsibility of the proposer.

c. Proposal Preparation Costs. The government is not responsible for any monies expended by the proposer before award of any contract.

d. Government Obligations. This Program Solicitation is not an offer by the government and does not obligate the government to make any specific number of awards. Also, awards under this program are contingent upon the availability of funds.

e. Unsolicited Proposals. The SBIR Program is not a substitute for existing unsolicited proposal mechanisms.

Unsolicited proposals will not be accepted under the SBIR Program in either Phase I or Phase II.

f. Duplication of Work. If an award is made pursuant to a proposal submitted under this Program Solicitation, the contractor will be required to certify that he or she has not previously been, nor is currently being, paid for essentially equivalent work by an agency of the Federal Government.

g. Classified Proposals. If classified work is proposed or classified information is involved, the offeror to the solicitation must have, or obtain, security clearance in accordance with the Industrial Security Manual for Safeguarding Classified Information (DoD 5220.22M).

6.0 SUBMISSION OF PROPOSALS

An original plus (4) copies of each proposal or modification will be submitted, in a single package, as described below, unless otherwise stated by specific instructions in Section 8.0.

NOTE: THE ORIGINAL OF EACH PROPOSAL MUST CONTAIN A COMPLETED APPENDIX A (COVER SHEET) AND APPENDIX B (PROJECT SUMMARY), AND A COMPANY COMMERCIALIZATION REPORT, WHERE REQUIRED (see Section 3.4.n).

6.1 Address

Each proposal or modification package must be addressed to that DoD Component address which is identified for the specific topic in that Component's subsection of Section 8.0 to this solicitation.

The name and address of the offeror, the solicitation number and the topic number for the proposal must be clearly marked on the face of the envelope or wrapper.

Mailed or handcarried proposals must be delivered to the address indicated for each topic. Secured packaging is mandatory. The DoD Component cannot be responsible for the processing of proposals damaged in transit.

All copies of a proposal must be sent in the same package. Do not send separate information copies or several packages containing parts of the single proposal.

6.2 Deadline of Proposals

Deadline for receipt of proposals at the DoD Component is 2:00 p.m. local time, July 5, 1996. Any proposal received at the office designated in the solicitation after the exact time specified for receipt will not be considered unless it is received before an award is made, and: (a) it was sent by registered or certified mail not later than June 28, 1996 or (b) it was sent by mail and it is determined by the government that the late receipt was due solely to mishandling by the government after receipt at the government installation.

Note: There are no other provisions for late receipt of proposals under this solicitation.

The only acceptable evidence to establish (a) the date of mailing of a late-received proposal sent either by registered mail or certified mail is the U. S. Postal Service postmark on the wrapper or on the original receipt from the U. S. Postal Service. If neither postmark shows a legible date, the proposal shall be deemed to have been mailed late. The term postmark means a printed, stamped, or otherwise placed impression (exclusive of a postage meter machine impression) that is readily identifiable without further action as having been supplied and affixed on the date of mailing by employees of the U. S. Postal Service. Therefore, offerors should request the postal clerk to place a hand cancellation bull's-eye postmark on both the receipt and the envelope or wrapper; (b) the time of receipt at the government installation is the time-date stamp of such installation on the proposal wrapper or other documentary evidence of receipt maintained by the installation.

Proposals may be withdrawn by written notice or a telegram received at any time prior to award. Proposals may also be withdrawn in person by an offeror or his authorized representative, provided his identity is made known and he signs a receipt for the proposal. (NOTE: the term telegram includes mailgrams.)

Any modification or withdrawal of a proposal is subject to the same conditions outlined above. Any modification may not make the proposal longer than 25 pages (excluding company commercialization record). Notwithstanding the above, a late modification of an otherwise successful proposal which makes its terms more favorable to the government will be considered at any time it is received and may be accepted.

6.3 Notification of Proposal Receipt

Proposers desiring notification of receipt of their proposal must complete and include a self-addressed stamped envelope and a copy of the notification form (Reference A) in the back of this brochure. If multiple proposals are submitted, a separate form and envelope is required for each. Notification of receipt of a proposal by the government does not by itself constitute a determination that the proposal was received on time or not. The determination of timeliness is solely governed by the criteria set forth in Section 6.2.

6.4 Information on Proposal Status

Evaluation of proposals and award of contracts will be expedited, but no information on proposal status will be available until the final selection is made. However, contracting officers may contact any and all qualified proposers prior to contract award.

6.5 Debriefing of Unsuccessful Offerors

Upon written request and after final award decisions have been announced, a debriefing will be provided to unsuccessful offerors for their proposals.

6.6 Correspondence Relating to Proposals

All correspondence relating to proposals should cite the SBIR solicitation number and specific topic number and should be addressed to the DoD Component whose address is associated with the specific topic number.

7.0 SCIENTIFIC AND TECHNICAL INFORMATION ASSISTANCE

7.1 DoD Technical Information Services Available

Recognizing that small businesses may not have strong technical information service support, the Defense Technical Information Center (DTIC) gives special attention to the needs of DoD SBIR Program participants. DTIC information support assists firms preparing SBIR and other R&D proposals to DoD in making informed bid decisions and technically stronger submittals.

DTIC, a major component of the DoD Scientific and Technical Information Program, serves DoD and other federal agencies and their contractors by managing and providing technical information resulting from and describing DoD-funded research and development.

DTIC also provides access to specialized reference services and subject matter expertise within the DoD-sponsored Centers for Analysis of Scientific and Technical Information (IACs), which are concerned with engineering, technical and scientific documents and databases worldwide.

For the majority of SBIR topics, DTIC prepares a Technical Information Package (TIP), containing a bibliographic listing of DoD-funded work in technical areas related to the topic. Many TIPs also include information provided by the topic author and references to other information sources.

Firms responding to this solicitation are encouraged to use Reference B at the back of this solicitation to request TIPs covering their proposal topic areas. Requests may also be submitted by telephone, fax, or email. In addition, TIPs are available online via the DTIC SBIR Home Page on Internet.

DTIC will return requested material, along with a user code for use in obtaining additional information or technical reports. In support of SBIR proposal preparation, up to ten technical reports may be ordered at no cost from DTIC during a solicitation period.

Online services, accessed via the DTIC Home Page (http://www.dtic.dla.mil/dtic/sbir), include TIPs as well as current DoD SBIR and STTR solicitations and award abstracts publications. Solicitation and awards information is also accessible via gopher (gopher.dtic.dla.mil) on port 70, or file transfer (asc.dtic.dla.mil). The FTP login is "anonymous", password is your E-Mail address, SBIR files are in the /pub/sbir directory. Also on Internet is SITIS for technical questions and answers concerning DoD topic descriptions. See section 7.2 for a complete description of this important service.

Call, or visit (by prearrangement) DTIC at the location most convenient to you. Written communications must be made to the Ft. Belvoir, Va., address.

Defense Technical Information Center
ATTN: DTIC-SBIR
8725 John J Kingman Road, Suite 0944
Ft. Belvoir, VA 22060-6218
(800) 363-7247 (800 DOD-SBIR)
(703) 767-8228 (FAX)
EMail sbir@dtic.dla.mil
WWW http://www.dtic.dla.mil/dtic/sbir

DTIC Boston Regional Office
Building 1103, 5 Wright Street
Hanscom AFB
Bedford, MA 01731-5000
(617) 377-2413

DTIC Albuquerque Regional Office
PL/SUL
3550 Aberdeen Ave, SE
Kirtland AFB, NM 87117-6008
(505) 846-6797

DTIC Dayton Regional Office
2690 C Street, Suite 4
Wright-Patterson AFB, OH 45433-7552
(513) 255-7905

DTIC Los Angeles Regional Office
222 N. Sepulveda Blvd., Suite 906
El Segundo, CA 90245-4320
(310) 335-4170

7.2 SBIR Interactive Topic Information System (SITIS)

Small businesses may ask technical questions about the solicitation topics in Section 8 by using the DTIC/MATRIS SBIR Interactive Topic Information System (SITIS), an anonymous electronic forum between participant small businesses and the DoD scientists and engineers assigned to SBIR topics. SITIS should not be used to ask general questions about the program or solicitation, which instead should be directed to (800) 382-4634.

SITIS is accessible through the World Wide Web at: **http://dticam.dtic.dla.mil/www/sbir/sbir.html** (you can link to SITIS using Mosaic, Netscape, etc.). Technical questions about solicitation topics can also be submitted via e-mail, fax, paper mail, or telephone by contacting the SBIR Coordinator at:

Defense Technical Information Center
MATRIS Office, DTIC-AM
ATTN: SBIR Coordinator
53355 Cole Rd.
San Diego, CA 92152-7213
Phone: (619) 553-7000
Fax: (619) 553-7053
Email: sbir@dticam.dtic.dla.mil
WWW: http://dticam.dtic.dla.mil/www/sbir/sbir.html

SITIS electronically posts all questions and answers by topic number, for general viewing, throughout the pre-solicitation and solicitation period. Answers are generally posted within seven working days of question submission. (Answers will also be emailed or faxed directly to the inquirer if the inquirer provides an email address or fax number.) Questions will be accepted until 30 days before the solicitation closing date.

In addition to managing SITIS, the MATRIS Office also provides information services in the areas of manpower, personnel, training and simulation, human factors, and safety.

7.3 Other Technical Information Assistance Sources

Other sources provide technology search and/or document services and can be contacted directly for service and cost information. These include:

National Technical Information Services
5285 Port Royal Road
Springfield, VA 22161
(703) 487-4600 (PH)/ (703) 321-8547 (FAX)

University of Southern California
Technology Transfer Center
3716 South Hope Street, Suite 200
Los Angeles, CA 90007-4344
(800) 872-7477 (outside CA)
(213) 743-6132
(213) 746-9043 (FAX)

Center for Technology Commercialization
Massachusetts Technology Park
100 North Drive
Westborough, MA 01581
(508) 870-0042
(508) 366-0101 (FAX)

Great Lakes Technology Transfer Center/Battelle
25000 Great Northern Corporate Center, Suite 260
Cleveland, OH 44070
(216) 734-0094
(216) 734-0686 (FAX)

Midcontinent Technology Transfer Center
Texas Engineering Experiment Station
The Texas A&M University System
301 Tarrow, Suite 119
College Station, TX 77843-8000
(409) 845-8762
(409) 845-3559 (FAX)

Mid-Atlantic Technology Applications Center
University of Pittsburgh
823 William Pitt Union
Pittsburgh, PA 15260
(800) 257-2725
(412) 648-7000
(412) 648-7003 (FAX)

Southern Technology Application Center
University of Florida, College of Engineering
Box 24, One Progress Boulevard
Alachua, FL 32615
(904) 462-3913
(800) 225-0308 (outside FL)
(904) 462-3898 (FAX)

Federal Information Exchange, Inc.
555 Quince Orchard Road, Suite 200
Gaithersburg, MD 20878
(301) 975-0103
(301) 975-0109 (FAX)

7.4 DoD Counseling Assistance Available

Small business firms interested in participating in the SBIR Program may seek general administrative guidance from small and disadvantaged business utilization specialists

located in various Defense Contract Management activities throughout the continental United States. These specialists are available to discuss general administrative requirements to facilitate the submission of proposals and ease the entry of the small high technology business into the Department of Defense marketplace. The small and disadvantaged business utilization specialists are expressly prohibited from taking any action which would give an offeror an unfair advantage over others, such as discussing or explaining the technical requirements of the solicitation, writing or discussing technical or cost proposals, estimating cost or any other actions which are the offerors responsibility as outlined in this solicitation. (See Reference C at the end of this solicitation for a complete listing, with telephone numbers, of Small and Disadvantaged Business Utilization Specialists assigned to these activities.)

7.5 State Assistance Available

Many states have established programs to provide services to those small firms and individuals wishing to participate in the Federal SBIR Program. These services vary from state to state, but may include:

- Information and technical assistance;
- Matching funds to SBIR recipients;
- Assistance in obtaining Phase III funding.

Contact your State Government Office of Economic Development for further information.

8.0 TECHNICAL TOPICS

Section 8 contains detailed topic descriptions outlining the technical problems for which DoD Components request proposals for innovative R&D solutions from small businesses. Topics for each participating DoD Component are listed and numbered separately. Each DoD Component Topic Section contains topic descriptions, addresses of organizations to which proposals are to be submitted, and special instructions for preparing and submitting proposals to organizations within the component. Read and follow these instructions carefully to help avoid administrative rejection of your proposal.

Appendices A, B, C and D follow the Component Topic Sections. Appendix A is a red-printed Proposal Cover Sheet, Appendix B is a red-printed Project Summary form, Appendix C is an outline for the Cost Proposal, and Appendix D is the Fast Track Application Form. A copy of Appendix A and Appendix B must be included with each proposal submitted.

Many of the topics in Section 8 contain references to technical literature or military standards, which may be accessed as follows:

- References with "AD" numbers are available from DTIC, by calling 800/DoD-SBIR or sending an e-mail message to sbir@dtic.dla.mil
- References with "MIL-STD" numbers are available from the DoD Index of Specifications and Standards (DODISS) at Internet address http://www.dtic.mil/dps-phila/dodiss
- Other references can be found in your local library or at locations mentioned in the reference.

U.S. ARMY 96.2
SUBMISSION OF PROPOSALS

Topics

The Army participates in one solicitation each year with a coordinated Phase I and Phase II proposal evaluation and selection process. The Army has identified 179 technical topics for this solicitation which address the Technology Areas in the Defense Technology Plan and the Army Science and Technology Master Plan. The commercial potential for each of these topics has also been identified.

Operating and Support Cost Reduction (OSCR)

The U.S. Army spends a large part of its overall budget, directly or indirectly, on the operation and support (O&S) of equipment ranging from small generators to large, sophisticated weapon systems. O&S costs cover a broad spectrum of items including spare/repair parts, fuels, lubricants, and the facilities and people involved in training operators and mechanics. The Army is seeking ways to reduce these costs as a broad Acquisition Reform initiative. To this end, the Army has implemented the Operating and Support Cost Reduction (OSCR) Program.

This solicitation includes 35 topics which address specific OSCR concerns identified by the Army's research and development community. In addition, a broad, generic topic has been included to ensure that any OSCR ideas can be submitted and evaluated. Please note that any proposals submitted against this generic topic must be structured within the Phase I/Phase II framework, must address an Army OSCR issue, and must provide an excellent opportunity for commercialization of the concept beyond the SBIR program. The OSCR topics have been grouped together at the end of the Army topics to benefit offerors who are specifically interested in cost reduction applications.

Technology Areas

Each Army SBIR topic is tied to one of the 20 technology areas, listed below, which are described in the Army Science and Technology Master Plan.

1 Aerospace Propulsion and Power
2 Air Vehicles
3 Chemical and Biological Defense
4 Clothing, Textiles, and Food
5 Command, Control, and Communications (C3)
6 Computing
7 Conventional Weapons
8 Electronics
9 Electronic Warfare/Directed Energy Weapons
10 Environmental Quality and Civil Engineering
11 Battlespace Environments
12 Human-Systems Interface (HSI)
13 Manpower, Personnel, and Training
14 Materials, Processes, and Structures

15 Medical
16 Sensors
17 Ground Vehicles
18 Software
19 Manufacturing Science & Technology (MS&T)
20 Modeling and Simulation (M&S)

Proposal Guidelines

The maximum dollar amount for Army Phase I awards is $100,000 and for Phase II awards is $750,000. Selection of Phase I proposals will be based upon technical merit, according to the evaluation procedures and criteria discussed in this solicitation document. Due to limited funding, the Army reserves the right to limit awards under any topic and only those proposals considered to be of superior quality will be funded. To reduce the funding gap between Phase I and Phase II, the Army follows a disciplined milestone process for soliciting, evaluating, and awarding superior Phase II proposals. Phase II proposals are invited by the Army from Phase I projects which have demonstrated the potential for commercialization of useful products and services. Invited proposers are required to develop and submit a commercialization plan describing feasible approaches for marketing developed technology. Cost sharing arrangements in support of Phase II projects and any future commercialization efforts are strongly encouraged, as are matching funds from independent third-party investors, per the SBIR fast track (see Section 4.5). Commercialization plans, cost sharing provisions, and matching funds from investors will be considered in the evaluation and selection process. Phase II proposers are required to submit a budget for a base year (first 12 months) and an option year. Phase II projects will be evaluated after the base year prior to extending funding for the option year.

Proposals not conforming to the terms of this solicitation and unsolicited proposals will not be considered.

Submission of Army SBIR Proposals

All proposals written in response to topics in this solicitation must be received by the date and time indicated in Section 6.2 of the introduction to the DoD solicitation. Be sure that you clearly identify the specific Army topic which your proposal addresses. All Phase I proposals (one original plus four copies) **must be submitted to the Army SBIR Program Office at the address shown below:**

Dr. Kenneth A. Bannister
Army Research Office--Washington
Room 8N31
5001 Eisenhower Avenue
Alexandria, VA 22333-0001
(703) 617-7425

Recommendation of Future Topics

Small Businesses are encouraged to suggest ideas which may be included in future Army SBIR solicitations. These suggestions should be directed at specific Army research and development organizations.

Inquiries

Inquiries of a general nature should be addressed to:

LTC John Peeler
Army SBIR Program Manager
HQDA
OASA RDA
Pentagon, Room 3E486
Washington, D.C. 20310-0103
(703) 614-7298

Dr. Kenneth A. Bannister
Army SBIR Program Coordinator
Army Research Office--Washington
Room 8N31
5001 Eisenhower Avenue
Alexandria, VA 22333-0001
(703) 617-7425

ARMY SBIR PROGRAM
POINTS OF CONTACT SUMMARY

U.S. Army Materiel Command

ARDEC	E. Serao	(201) 724-7349	A96-001 thru A96-016
ARL	D. Hudson	(301) 394-4808	A96-017 thru A96-033; A96-145 thru A96-152
ARO	M. Brown	(919) 549-4336	A96-034 thru A96-043; A96-153 thru A96-154
ARO-W	K. Bannister	(703) 617-8392	A96-179
AVRDEC	A. Smith	(804) 878-0155	A96-044 thru A96-054; A96-155
CECOM	J. Crisci	(908) 427-2665	A96-055 thru A96-081; A96-156 thru A96-159
ERDEC	R. Hinkle	(410) 671-2031	A96-082 thru A96-083; A96-160 thru A96-161
MICOM	O. Thomas, Jr.	(205) 842-9227	A96-084 thru A96-086; A96-162 thru A96-172
NRDEC	G. Raisenan	(508) 233-5296	A96-087 thru A96-089; A96-173 thru A96-175
STRICOM	A. Piper	(407) 380-4287	A96-090 thru A96-093; A96-176 thru A96-177
TACOM	A. Sandel	(810) 574-7545	A96-094 thru A96-105; A96-178
TECOM	R. Cozby	(410) 278-1481	A96-106 thru A96-112

U.S. Army Corps of Engineers

COE/CERL	M. Marlatt	(217) 373-7290	A96-113 thru A96-114
COE/CRREL	S. Borland	(603) 646-4735	A96-115 thru A96-116
COE/TEC	J. Jamieson	(703) 428-6631	A96-117 thru A96-118
COE/WES	P. Stewart	(601) 634-4113	A96-119 thru A96-120

Deputy Chief of Staff for Personnel

ARI	J. Psotka	(703) 617-5572	A96-121 thru A96-123

U.S. Army Space and Strategic Defense Command

SSDC	E. Bird	(205) 955-4871	A96-124 thru A96-130

Surgeon General

MRMC	H. Willis	(301) 619-2471	A96-131 thru A96-144

DEPARTMENT OF THE ARMY
PROPOSAL CHECKLIST

This is a Checklist of Requirements for your proposal. Please review the checklist carefully to assure that your proposal meets the Army SBIR requirements. Failure to meet these requirements may result in your proposal being returned without consideration. Do not include this checklist with your proposal.

_____ 1. The proposal is limited to only ONE ARMY solicitation topic.

_____ 2. The proposal is 25 pages or less in length. (Excluding company commercialization report.) Proposals in excess of this length will not be considered for review or award.

_____ 3. The Cover Sheet (Appendix A) has been completed and is PAGE 1 of the proposal. The actual RED COPY of Appendix A is included on the original proposal.

_____ 4. The proposal budget may be up to $100,000 and duration does not exceed six months.

_____ 5. The Project Summary Sheet (Appendix B) has been completed and is PAGE 2 of the proposal. The actual RED COPY of Appendix B is included on the original proposal.

_____ 6. The Technical Content of the proposal begins on PAGE 3 and includes the items identified in Section 3.4 of the Solicitation.

_____ 7. The Technical Abstract contains no proprietary information, does not exceed 200 words, and is limited to the space provided on the Project Summary Sheet (Appendix B).

_____ 8. The proposal contains only pages of 8 1/2" x 11" size. No other attachments such as disks, video tapes, etc. are included.

_____ 9. The proposal contains no type smaller than 11 point font size (except as legend on reduced drawings, but not tables).

_____ 10. The Contract Pricing Proposal (Appendix C) has been completed and is included as the last section of the proposal.

_____ 11. The final proposal is stapled in the upper-left-hand corner, and no special binding or covers are used.

_____ 12. An original and four copies of the proposal are submitted.

_____ 13. The Company Commercialization Report, if required, in accordance with Section 3.4.n.

_____ 14. A self-addressed stamped envelope and a copy of the Notification Form (Reference A) in the back of the solicitation book, if notification of proposal receipt is desired.

_____ 15. The proposal must be sent by registered or certified mail, postmarked by June 28, 1996, or delivered to the Army SBIR Office no later than July 5, 1996, 2:00 p.m. local time as required (see Section 6.2).

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A96-028	Intelligent Wire Bond Pull Station for Microelectronics
A96-029	Machine Translation of Battlefield Messages
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U.S. Army Research Organization

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DEPARTMENT OF THE ARMY
FY 1996 TOPIC DESCRIPTIONS

U.S. Army Armaments Research, Development, and Engineering Center

A96-001 TITLE: Dual-Effect (Lethal and Non-Lethal) Weapons

CATEGORY: Exploratory Development

OBJECTIVE: To design, analyze, develop and demonstrate new, advanced concepts that provide both lethal and non-lethal target effects from the same direct fire weapon system/munition. The non-lethal capability will temporarily incapacitate/immobilize personnel targets without lethality, serious injury, or irreparable effects. Concepts should be dual use applicable to law enforcement or with other direct technology transfer capability to private/commercial sector.

DESCRIPTION: Reduction of potential logistics burden created by multiple different types of non-lethal munitions/armament systems may be essential considerations in fielding of future weapon systems which will be used in both combat and OOTW missions. Novel, advanced concepts that specifically address dual-effort (lethal and non- lethal) capable weapon systems/munitions where one weapon system and/or munition can be used in both lethal and non-lethal scenarios, based on operation controlled/activated mechanism (either manual or automatic) are of interest. Advanced concepts which address integrated mechanisms for adjusting projectile velocity, shape, or in-flight target impact performance, and the resultant target effect (lethal/non-lethal) use are of specific interest. Concepts must be applicable to one or more of the following calibers, listed in order of expected prevalence: 5.56mm, 20mm, 40mm, 12 gauge and 9mm.

Ideally, concepts will address one or more of the following attributes:
1. Near instantaneous, real-time, pre-firing selection of loaded ammunition (i. e., chambered ammunition, attached magazine, or muzzle launched) for either lethal or non-lethal target effect.
2. Lethal and non-lethal target effects from same system/munition at effective ranges comparable to standard ammunition or 10 meters minimum and 500 meters maximum.
3. Fool-proof/fail-safe selection/activation of desired target effect for the scenario such that a lethal round is not fired in a non-lethal situation, or vice versa.
4. Ability to automatically cycle weapon and chamber next round even after firing in the non lethal mode.

PHASE I: Conceptualize and design, as a minimum, and build and test prototype item(s) with above attributes. Demonstrate vitality of concept through analysis and/or simple prototype fabrication/lab test. Obtain contingent provision of funding commitment for potential Phase III effort.

PHASE II: Develop, construct, test and deliver one or more working prototypes for government verification of concept performance.

POTENTIAL COMMERCIAL MARKET: Future weapon systems/munitions for federal and local law enforcement.

A96-002 TITLE: Analysis Of X-Ray Images Using Wavelet & Fractal Methods

CATEGORY: Advanced Development

OBJECTIVE: Develop an x-ray data analysis system in which fractal and wavelet analysis methods are integrated with more traditional methods of analysis for analyzing x-ray multi-spectral images for identification of objects, object positions, and composition.

DESCRIPTION: The Army needs a limited but fairly numerous set of parameters that could be quickly calculated from x-ray radiographic images. The set of parameters must be adequate to identify and differentiate with a very high level of probability a host of materials both man-made and natural as seen in the radiographs.

The proposal should address the following unique attributes of the radiographs. An x-ray radiographic image is the superimposed shadow of all materials between the x-ray source and the imaging device. To a large extent the pixel value or density is a function of the distance through an item normal to the image plane. Curvature of an item can be extracted from the change in the pixel values across an item. The edge of an item often is seen as a sudden change in the rate of change of intensity across the image. The complex effect of superposition may be partially calculated out through careful logic. Natural substances should portray a different fractal content than man-made objects. Consideration should be given to combining wavelet transformations with fractal analysis, and calculations of first and second order changes in intensity across image segments. The images to be analyzed are actually a set of images, each image consisting of a different spectral band. The different spectral images are all spatially registered.

PHASE I: The Phase I proposal must include a first set of parameters to be calculated and the basis for their choice. The proposal must demonstrate familiarity with radiographic images. The proposal must show a logical and realistic approach to determining an all encompassing set of parameters for identification of objects in radiographs. The Phase I objective will be to calculate the proposed set of parameters for a representative set of radiographs to be provided by the Army; to demonstrate how well they identify and differentiate items in the radiographs; and to propose a more appropriate and thorough set of parameters to be worked on in Phase II.

PHASE II: Develop, construct, test and deliver a complete set x-ray data analysis algorithms which meets the objective of the solicitation. All of the algorithms must be interfaced as a set of functions to the National Institute of Health's "NIH IMAGE" program and placed in the public domain. A second version must be interfaced to an Army custom x-ray image processing system. All algorithms must be designed to process both eight and sixteen bit data, and to process images of mega-pixels in size. Algorithms must be very fast.

POTENTIAL COMMERCIAL MARKET: Potential military and commercial applications include radiographic and tomographic inspection of munition items, vehicle components, manufactured items, and medical diagnosis. Algorithms developed for radiographs should have use for analysis of visible light and infrared images as well. Applications would include machine vision, target identification, robotics and similar image analysis areas.

A96-003 TITLE: Fire Detection and Warning System Technology

CATEGORY: Exploratory Development

OBJECTIVE: Develop a low cost compact system that detects fire at an early stage and provides early warning for ammunition, fuel, and other hazardous material storage safety applications to enhance soldier survivability.

DESCRIPTION: Ammunition storage areas are not equipped with a fire warning system because no such system is available. Subsequently, many lives and vast quantities of property and material are lost as a result of fire due to accidents or enemy actions. The accident that occurred at Camp Doha, Kuwait after Desert Storm is a good example. That accident was initiated by a fire and caused the loss of millions of dollars worth of weapons and ammunition, and the loss of several lives during the cleanup operation of scattered munitions. That accident could have been prevented if the fire was detected at an early stage and quickly extinguished. Significant progress has been made in light sensor technology in the past decade. Various types of high quality light sensors have been developed to detect different light spectrums and are producible at very low costs. A system can be developed exploiting the technology advances in sensors (light or other) and early warning equipment to detect a fire in its initial stage and initiate a warning signal. The technical issues of the fire detection and warning system include: the ability to detect and locate fires quickly and cover a large area (from 1000 square feet to several square miles) over a wide field of view, robust design, function indoor and outdoor at the same temperature ranges required for ammunition (-60 to +165 degrees F), operate with standard Army and commercial batteries as well as 115 volts (AC), generate an audible warning signal that can be heard within 100 yards of the ammunition storage area, environmentally safe, compact, and lightweight.

PHASE I: Investigate new and innovative sensors to detect fires at an ammunition storage area. Establish preliminary design criteria for the sensor and audible warning system. Select the types of sensor and audible warning system technologies that are potential candidates for system development. Determine physical and performance characteristic required of the total sensing and warning system. Determine the configuration of the assembled sensors and warning system.

PHASE II: Develop test hardware, and plan for the detection and audible warning system components (sensor and warning mechanisms) and total system. Fabricate prototype test hardware, conduct testing on the prototype, and provide a final report that includes the specification of the system, unit cost, and test results.

POTENTIAL COMMERCIAL MARKET: The technology developed under this program may be utilized in any commercial storage and warehouse situation. The system will provide early detection and warning against fire and will aid in the prevention of life and property loss.

A96-004 TITLE: Ground Vehicle Classification by Acoustic Emission Exploitation

CATEGORY: Exploratory Development

OBJECTIVE: Develop improved signal classification capability utilizing advanced, programmable pattern recognition (PPR) techniques.

DESCRIPTION: The Army is currently developing and/or employing acoustic sensors for surveillance, intelligence gathering, and target acquisition functions (detect ion, classification, tracking, etc.). Low-cost, computationally powerful, Digital Signal Processing IC's are now widely available that can execute sophisticated signal processing techniques that extract and exploit information from acoustic emissions of, for instance, ground combat vehicles.

The identity, or more generally, the classification of an acoustic emitter is essential for assessing the threat it imposes to friendly forces. Contemporary classification techniques employed to categorize ground combat vehicles have, for the most part, been statistically based and have exhibited acceptable performance cap abilities in a medium to high signal to noise ratio scenarios. However in the low SNR situations, such as a vehicle at extended range, or a collection of vehicles, the performance of these same algorithms is substantially degraded.

The development of robust and innovative signal classification algorithms that employ advanced pattern recognition based signal processing is desired. Such processing would be capable of extracting recognizable features from acoustic emissions produced by ground combat vehicles. The prospective pattern recognition algorithm might exploit features from multiple processing domains, i.e. time, frequency, spatial, parametric. The algorithm must be robust enough to encompass normal variation of signal pattern descriptors. The approach should be flexible enough that signatures of observed sources can be incorporated into the algorithm without extensive modification. The algorithm should be innovative in that it should extend the capabilities of existing classical pattern recognition algorithms or be an entirely different and novel approach.

PHASE I: Develop methodology and algorithmic approach to novel PPR concept. Demonstrate the basic capability and effectiveness of the chosen approach, preferably, by playing the algorithm against existing tactical vehicle acoustic data available from the sponsor.

PHASE II: Refine the chosen PPR approach. Assemble the necessary hardware to demonstrate a real-time PPR capability. Expand the capability of the algorithm to discriminate multiple sources simultaneously and/or operate in a noise contaminated environment.

POTENTIAL COMMERCIAL MARKET: Rotating and reciprocating machinery diagnostics, failure mode prediction. Classification of small engine fixed-wing aircraft for drug trafficking surveillance/interdiction. Medical diagnostics, for example, fetal heart and umbilical bloodflow abnormality detection and identification. Voice detection/recognition.

A96-005 TITLE: Computed Tomography Algorithms for Helical Scanned Data

CATEGORY: Advanced Development

OBJECTIVE: Develop algorithms for high-speed Computed Tomography (CT) scanning and reconstruction with helical and pseudo-helical geometry.

DESCRIPTION: In order to increase throughput, computed tomography requires the part under inspection be continuously moving, rather than incrementally moving. The result is a helical scan. In order to decrease the size of the equipment, a non-circular x-ray source and sensor configurations are being employed. This solicitation is for algorithms for computing the tomographic slices from the helical scanned data coming from non-circular geometry. The algorithms must reconstruct 256,000 pixels or more, with limited artifacts, must compute rapidly (in milliseconds), must run on available processing equipment, must process raw data of up to fifteen bit accuracy.

PHASE I: Research and simulate algorithms for reconstruction of tomographic slices from helical scanned data taken with non-circular geometry. Attention must be given to freedom from artifacts, accuracy of dimensions and densities, spatial resolution, and techniques that can be accomplished at high speeds with reasonable processor hardware costs. Demonstrate the algorithms will meet the requirements. Obtain funding commitments for potential marketing and production.

PHASE II: Develop, construct, test and deliver one or more working prototype complete systems including all hardware, software, etc. The system will create tomographic images from helical scanned data taken with non-circular geometry. The algorithms must reconstruct 256,000 pixels or more, with limited artifacts, must compute rapidly (in milliseconds), must run on available processing equipment, must process raw data of up to fifteen bit accuracy.

POTENTIAL COMMERCIAL MARKET: Potential military and commercial applications include non-destructive inspection of munition items, vehicle components, manufactured items, and medical diagnosis.

A96-006 TITLE: Advanced Nonlinear and Hybrid Systems Control Technology

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate high performance nonlinear, adaptive, and hybrid systems control technology for precision multi-target/ multi-platform fire-on-the-move applications including armor, air defense and aircraft system applications.

DESCRIPTION: Recently progress has been made in demonstrating major accuracy improvements for both aircraft and combat vehicle weapon systems using advanced digital processing together with LQG/LTR and H-infinity design approaches. Further improvements in weapon accuracy and targeting performance are anticipated through the development of improved robust nonlinear and adaptive control laws, and hybrid control laws that account for both continuous as well as logical components of the system state vector. This project will address the broad spectrum of issues associated with the development of control law design tools and methodology, modeling, simulation, real time hardware/software implementation, and sensor/actuator technology.

PHASE I: Develop methodology for design and implementation of high performance robust adaptive, nonlinear and hybrid system control laws for precision weapon stabilization, tracking and targeting. Formulate specific stabilization, tracking and targeting control laws/decision strategies for multi-input, multi- output nonlinear plants, incorporating distributed smart senor/actuators, along with friction, backlash, resonant modes, high impulse periodic disturbances, nonlinear compliance, sensor noise, and multi-target sensor input. Determine performance and robustness characteristics with respect to model errors associated with both continuous and logical components of the domain model. Provide analysis of hardware/software implementation requirements to achieve real time performance, including sensor/actuator trade-offs.

PHASE II: Develop a fully integrated design and prototyping environment for advanced nonlinear, adaptive and hybrid control systems. Provide a real time programmable digital control module with on-line data analysis capability and I/O capability and sensor/actuator component hardware necessary for laboratory test bed evaluation. Optimize module hardware/software and algorithm design based on test data and provide complete documentation of algorithms and hardware/software architecture.

POTENTIAL COMMERCIAL MARKET: This work has a very high probability of being commercialized. The methodology, design environment, prototyping tools and component technology developed in this SBIR are applicable to manufacturing, machine tool, process control, engine control, transmission control and automation applications, including automobile and commercial aircraft manufacturing, robotics applications, precision instrumentation systems, flight controls etc. These applications are characterized by the presence of non linearities, parameter variations, backlash, friction, saturation and resonant modes, while large scale automation requires consideration of hybrid discrete event and continuous time system dynamics. This technology also has broad DOD applications, particularly in the area of affordable controls; distributed, multi-platform fire control and targeting; intelligent,multi-agent, cooperative systems; defense manufacturing, etc. The impact of the technology is two-fold: increasing performance through improved control software while reducing cost by reducing hardware cost and complexity and improving reliability and fault tolerance.

A96-007 TITLE: Intelligent Sensor Based Robotic Control System Technology

CATEGORY: Exploratory Development

OBJECTIVE: Develop a generic multi-adaptive robotic control module and development environment for mobile manipulator systems for ammunition handling, resupply and logistics applications. Module must address task level as well as servo level functionality and be architectured to accommodate variations in manipulator/ platform configurations and task requirements.

DESCRIPTION: Significant progress has been made recently in developing advanced sensor based servo control systems for high performance robotic manipulators. Specifically, a high speed 386 based multi-processor robotic control module and software development environment was developed which permits a broad range of adaptive and compliant motion control strategies to be implemented for arbitrary manipulator configurations. Extensions of this technology are required, however, to deal with fundamental problems of mobility and base motion effect, flexible task level control, multi-sensor integration, dual arm coordination associated with fusing ammunition in a moving resupply vehicle, and depalletizing and transferring ammunition to and from resupply vehicle and loading ammunition in a moving platform environment. Technical issues of interest include robust and adaptive controls, compliant motion control, visual servo control, voice natural language interface for control, dual arm control strategies, world modeling design environment, real time, knowledge based task level control and control from moving base including path planning, navigation and obstacle detection/ avoidance and component based software architectures.

PHASE I: Develop methodology and algorithmic approaches to intelligent sensor based robotic control systems for applications to materiel handling and loading. Perform preliminary modeling and simulation studies to determine performance/ robustness characteristics of the control laws and algorithms, real time processing requirements and sensor requirements. Provide analysis for evaluating control laws and provide control processor design and system hardware specifications.

PHASE II: Develop controller hardware/software and development environment for interface with laboratory test bed manipulator systems. Develop test scenarios and scaled down mock-ups to demonstrate controller performance capabilities. Provide fully integrated prototype module with documentation source code and development environment and evaluate in laboratory tests.

POTENTIAL COMMERCIAL MARKET: The technology developed under this program can be utilized on any production line performing product handling, part mating and product transferring applications. The technology is also applicable to automated warehousing, handling of hazardous materials, security, law enforcement and medical/ surgical applications. Particularly, for the Army, this technology can be used in programs like FARV-A and Crusader to perform ammunition fusing, depalletizing, handling and loading during re-supply operations.

A96-008 TITLE: Development of New Catalysts for Synthesis of Energetic Materials

CATEGORY: Basic Research

OBJECTIVE: Design of novel catalysts to facilitate synthesis of energetic materials and commercially viable products.

DESCRIPTION: In the research and development stages of new explosives and propellants as well as in the production of these materials, enormous amounts of toxic and hazardous waste materials are being generated as by-products. Disposal of these toxic materials causes serious problems for the DOD operations. Novel catalysts can be used to remove these toxic waste by-products, as well as to increase the yield of the chemical reactions in the synthesis of explosive and propellant molecules. Catalysts, which are generally used in very small amounts, enhance chemical reactions but can be recovered from the reaction intact. Therefore, it is proposed that studies be conducted on the adsorption properties of individual contaminant species such as heavy metal cations and other toxic waste by-products on various catalytic surfaces. New molecular modeling techniques provide relevant information about how chemicals react at the molecular level and thus facilitate the application of new catalysts to fit specific chemical need. Therefore, it would be of considerable interest to design new catalysts and apply their catalytic potential to remove metal cations and other hazardous by-products from toxic waste materials. This includes adsorption and ion exchange to catalyst such as clay and ion exchange resins.

PHASE I: Investigation of adsorption and ion exchange properties of catalysts using molecular modeling techniques. Based on these results, develop new catalysts and surfactants for removal of heavy metal cations and other hazardous by-products from toxic waste. Optimize the catalytic reactivity of these catalysts by conducting relevant experiments.

PHASE II: Upon successful completion of Phase I of this program, apply these new catalysts in reducing hazardous by-products from toxic waste. Develop a data base to determine which catalysts is most suitable to type of operations on interest

to Army. Based on these data, develop methodology and algorithmic approaches to identify suitable catalysts. Optimize the catalytic reactivity of these catalysts by conducting relevant experiments

POTENTIAL COMMERCIAL MARKET: Novel and cost effective methods towards the elimination of heavy metal cations and other by-products from toxic waste materials generated in chemical industry. Another potential application is to use in chemical weapons disposal technology, where detoxification of chemical weapons can considerably reduce the environmental and safety concerns.

A96-009 TITLE: Low Cost Radio Frequency Smart Tags & Applicator

CATEGORY: Exploratory Development

OBJECTIVE: Develop low cost Radio Frequency (RF) smart tags or labels which can be remotely programmed and remotely read-out that contains thousands of bytes of information and a machine to apply the tags to bags and crates of arbitrary shape and material covering.

DESCRIPTION: Smart tags are presently used for a number of applications in the civilian and military sectors, including item identification, toll passes, and barrier identification. Such tags are relatively expensive (several dollars) and are limited in the amount of information they can carry. The Army needs tags costing a few cents that can be affixed to individual items. The tag must recognize and respond to external RF interrogation signals. The external RF interrogator will be in the vicinity of one meter from the tag. The contents of the tag must be read out or written to through the RF link. Improved designs should include simple local interface for acquiring data from local sensors such as temperature and pressure. Along with the tag, the contractor should develop an applicator to apply the tag to packages, bags, boxes, and crates, of various thickness and stiffness while they are being conveyed by a conveyor at fairly rapid but consistent rate. The tag must be applied to the item as it is moving. The exact orientation and position of the item to be tagged can be arbitrary. The items conveyed past the applicator can be in any order, shape or size. The material covering the item can be cloth, metal, paper, or wood. The covering may be soft or firm. The applicator must keep up with conveyor speeds of two hundred feet per minute with items as close together as three feet.

PHASE I: Create and deliver designs for the low cost remotely accessible RF smart tags. Demonstrate that the designs will meet the requirements, preferably by building a simple prototype tag and data access device, or a laboratory demonstration. Prepare a preliminary design of the proposed tag applicator. Carry out a feasibility study by demonstrating experimentally that the applicator concept works. Obtain funding commitments for potential marketing and production.

PHASE II: Develop, construct, test and deliver one or more working prototype smart tag systems including tags and remote reading apparatus and tag applicator.

POTENTIAL COMMERCIAL MARKET: Due to their low cost applications include tagging individual items where the tag can be disposed of when the item is put into use. Potential military applications include tagging individual weapons, munitions or pieces of equipment, crates, and other inventory. Potential civilian uses include tagging luggage on aircraft, tagging parcels, packages, crates, and individual items, employee identification, vehicle identification.

A96-010 TITLE: On Site Bioaccumulation of Heavy Metals

CATEGORY: Exploratory Development

OBJECTIVE: To develop and demonstrate biological methods for the on-site treatment and/or removal of heavy metals from contaminated soils. The approach should have the ability to treat contaminated soils to reduce metal concentrations below regulatory standards within a time frame of 1 - 5 years of treatment. The method should be applicable to the treatment of a range of different heavy metals, site characteristics and geographical areas.

DESCRIPTION: Heavy metal contaminated soils in many areas, including military sites, represent substantial volumes of solid material. Conventional treatment methods either do not remove the metal from the site, or require soil excavation and treatment or disposal, with significant associated costs. Low cost, on-site methods are needed to treat metals in soils to reduce their concentration and environmental impact without extensive excavation and off-site disposal. Recent developments in the identification of biological processes that accumulate heavy metals may be applicable to the treatment of contaminated soils at the low costs associated with bioremediation methods for the removal of organic contaminants.

PHASE I: Identify methods for the uptake of heavy metals from soil by living organisms in amounts that could lead to the treatment of contaminated sites. Develop methods for evaluating treatment efficiency on actual contaminated soil.

PHASE II: Field test the biological approach at a DOD related site and identify an economical method for treating and disposing of the metal-containing biomass.

POTENTIAL COMMERCIAL MARKET: A large civilian and Federal Agency market exists for low-cost methods of treating heavy metal contaminated soils. Closed CONUS and OCONUS military sites, formerly used defense sites (FUDS), petrochemical facilities, smelter deposition areas and battery recycling sites are examples of potential heavy metal contaminated locations. This technology may also be expanded to the treatment of radionuclide contaminated soils at DOE facilities.

A96-011 TITLE: Software Infrastructure/ Reuse Technology For Embedded Applications

CATEGORY: Exploratory Development

OBJECTIVE: Develop design, analysis and prototyping tools and technology to support specification, implementation and evaluation of standard software reference architectures and application components for embedded/smart weapon applications.

DESCRIPTION: Embedded software will be a key cost driver in next generation smart and brilliant weapon/ fire control systems due to increased computational and software complexity, stringent hard real time computational constraints, and the high cost associated with software testing, verification, validation, and software maintenance and support. A key enabling technology for managing and controlling software cost and complexity is the development of standardized reference or product line architectures and supporting infrastructure technology, tools and design methodology. Progress to date includes the development of an architecture schema and architecture description language which provides a formal mechanism for describing architecture components and interconnections, together with preliminary repository tools for storing, manipulating and visualizing schema data. Further extensions of this technology is required, however, to provide complete end-to-end software development support for embedded weapon applications. Specific requirements exist for (1) domain modeling and analysis tools and methodology which are tailored for extracting reference architecture requirements (2) architecture description languages that provide sufficient expressive power to represent component functionality, component interface connections, control and data communication paradigms, etc. and support detailed analysis of architecture behavior/performance (3) a repository tool with graphical user interface that supports storage, manipulation, browsing and retrieval of application architecture descriptions and components and the composing of new application systems from existing or reengineered components. (4) development of reference/ product line architecture specifications for embedded weapon/ fire control systems that facilitates reuse of components within the application domain (e.g. smart mines, smart mortars, intelligent artillery crew associates, armor, etc.) (5) development of generic architecture/application components that conform to reference architecture specifications to include real time data base management, real time, intelligent multi-processor/multi-tasking os, MMI, digital mapping, real time planning, resource management/allocation, hybrid systems control, etc. (6) application generators. (7) metrics for determining conformance of application architectures to reference architecture specifications (8) high level technical architecture standards and guide lines that extend the Army C4I TA to embedded weapon applications.

PHASE I: Assess maturity and capability of existing tool environments to support an end-to-end architecture based software development process for embedded weapon applications. Develop preliminary requirements for an integrated tool environment that fully supports an architecture driven software development process. Identify high level technical architecture standards and guidelines for embedded weapon/ fire control applications.

PHASE II: Develop tools and supporting design methodology for executing, as a minimum, critical process threads associated with (a) reference architecture extraction from domain models, (b) representation, analysis and archiving of application architecture descriptions, (c) requirements tracking, (d) application generation based on composing reusable/reengineered components, from component repositories, with possibly new components produced via component generators. Demonstrate and validate technology by populating a baseline reuse component repository and composing a laboratory application prototype. Identify/assess existing ACOE and commercial components compatible with embedded weapon system requirements.

POTENTIAL COMMERCIAL MARKET: This topic will provide enabling technology that supports component based software development, reuse and interoperability of all large scale, distributed, real time software systems such as those associated with factory automation, command and control, health services, banking, environmental monitoring, communication networks, smart highway systems, air traffic control, law enforcement networks etc.

A96-012 TITLE: Label Applicator for Arbitrary Surfaces

CATEGORY: Engineering Development

OBJECTIVE: Develop a machine to apply fairly stiff labels and tags to bags and crates of arbitrary shape and material covering.

DESCRIPTION: The Army needs a machine which can apply labels of various thickness and stiffness to packages, bags, boxes, crates, and containers being conveyed by a conveyor at fairly rapid but consistent rate. The label must be applied as the item is moving. The exact orientation and position of the item to be labeled can be arbitrary. The items conveyed past the labeler can be in any order, shape or size. The material covering can be cloth, metal, paper, or wood. The covering may be soft or firm. The machine must keep up with conveyor speeds of up to several hundred feet per minute with items as close together as three feet. The applicator must be able to handle and apply Radio Frequency (RF) smart tags without destroying them.

PHASE I: Prepare a preliminary design of the proposed system. Carry out a feasibility study by demonstrating experimentally that the concept works. Obtain funding commitments for potential marketing and production.

PHASE II: Develop, construct, test, demonstrate and deliver a full scale prototype complete system.

POTENTIAL COMMERCIAL MARKET: Potential military applications include tagging individual weapons, munitions or pieces of equipment, crates, vehicles and other inventory. These applications could be in support of stockpile surveillance or inventory control. Commercial and military market includes logistics, trucking, shipping, checked-in airline luggage, mail--any industry which stores, moves, and delivers an arbitrary mixture of sundry products.

A96-013 TITLE: Development of New Alternate Synthetic Procedures for 1,3,3-Trinitroazetidine (TNAZ)

CATEGORY: Basic Research

OBJECTIVE: Research toward finding and developing a high yielding alternate synthetic procedure for TNAZ.

DESCRIPTION: TNAZ is a new steam-castable, superior performing explosive under development by the Army. Applications of TNAZ as a demolition and anti-armor explosive, and as a component in LOVA propellants, are being explored. It is markedly more powerful than LX-14, the Army's most powerful in-service explosive formulation. TNAZ is currently prepared by an inefficient and environmentally unfriendly five-step batch process, with an overall yield of about 15%; or by an alternate process, under development by Los Alamos National Laboratory, with higher yields, but producing large quantities of hazardous waste. In view of the desirable properties of TNAZ and its prospect to be fielded in the near future, there is an urgent need for its production in large amounts via a high- yield process. This is the focus of this topic.

PHASE I: Conduct basic research to: find a new high yielding and environmentally friendly procedure for synthesizing TNAZ; or, develop economically viable methodologies to recycle the N,N'-dialkylhydrazine and triphenylphosphine oxide produced in the Los Alamos process.

PHASE II: Scale up the new procedure to demonstrate low-cost 1 - 50 pound batch production of all intermediates and TNAZ. Provide process engineering drawings for a large scale plant. Develop optimized process conditions on pilot plant equipment.

POTENTIAL COMMERCIAL MARKET: TNAZ should find applications in propulsion of non- military items, e.g. commercial rockets. It is expected to be a superior commercial demolition explosive. DNAZ nitrate, a chemical precursor to TNAZ, is water soluble and should find applications as a commercial blasting agent superior to currently used Ammonium Nitrate/Fuel Oil in performance.

A96-014 TITLE: Cage Molecular Derivatives in Explosive Research for More Powerful Explosives and Civilian Optical Materials

CATEGORY: Basic Research

OBJECTIVE: Prepare more powerful explosives and other potential compounds from cage derivatives for use as liquid crystals or non-linear optical materials.

DESCRIPTION: Cubyl and Adamantyl carbonyl chlorides are near precursors for more powerful explosives. One aspect of this effort would be to prepare more powerful and insensitive explosives based on such cage forms. Octanitrocubane, for example, is a super explosive that is anticipated to provide about 30% more explosive power than LX-14, the military's most powerful current explosive formulation. Chlorocarbonyl derivatives of cubanes and adamantanes have their functionalities in a spherical symmetry and they can be derivatized as star polymers. Star polymers have generally higher thermal stability, higher glass transition temperature and higher solubility than linear (two arms) polymers. They have ability to provide long electric dipoles. These systems are potentially used as liquid crystals and non-linear optical materials. The second aspect, thus, of this effort would be to develop such critically useful civilian materials from the cage derivatives.

PHASE I: Conduct a detailed literature search and computer modeling studies to select model polymeric cage systems that are useful as liquid crystals and non- linear optical materials. Perform synthetic research that would be feasible for obtaining such polymer structures.

PHASE II: Complete the synthesis of the above compounds and conduct an in-depth study of their material properties (e. g. Non-linear optical and liquid crystal). Down select suitable compounds for Phase III work.

POTENTIAL COMMERCIAL MARKET: Non-linear optical materials are very useful in frequency manipulation (e. g. frequency blending, frequency doubling and quadrupling) of laser beams and they are critically useful for military and civilian communication systems. Liquid crystal materials are essential ingredients in military and civilian display devices such as night vision binoculars, intelligent storage etc. The market is very significant in military industry. The market in civilian industry is very large and they would be picked up by the major participants (e. g. AT&T, Sprint, MCI etc.) in communication industry.

A96-015 TITLE: Fuzing Sensors and Signal Processors

CATEGORY: Exploratory Development

OBJECTIVE: Develop sensors and signal processing technology and components necessary for next generation fuzing systems and subsystems. Appropriate technology candidates must enhance safety, reliability and producibility in order to be considered for fuzing systems.

DESCRIPTION: Typical fuzes consist of sensor, signal processor, power supply, and safety and arming subsystems. A fuze must not only endure decades of storage in adverse conditions, but must also withstand extreme ballistic launch environments and still function a munition safely and reliably on the intended target. Not only is fuze performance critical to the mission, but cost is also extremely important because fuzes may be produced in large quantities for the military stockpile. Fuze sensors are required that can reliably discriminate targets from the background clutter at selected ranges from impact to 2 km. Sensors of interest include radar (microwave through millimeter wave), active and passive optical, electrostatic (ESS), magnetic, inductive and acoustic types. Components of particular interest include: broadband antennas, antenna arrays, precision time bases and optical assemblies. Small size, gun or missile launch survivability and low cost are principal driving requirements. Sensors must also be able to withstand the appropriate electromagnetic effects environments without causing a safety or reliability failure. Signal processors are required to enhance the ability of sensors to reject false targets, control the burst point, and sense a proper target even when subjected to strong countermeasures. Signal processors may use analog circuits, digital circuits, microprocessors or a combination of these to determine that the desired burst point has been reached. Signal processing may fuse the data from two independent sensors to enhance the probability of detecting a proper target. Miniature signal processors comprised of integrated circuits, or multi-chip modules that are small enough to fit into standard fuze contours for artillery, mortars and medium caliber cannon cartridges are of particular interest.

PHASE I: Identify promising fuzing technologies. Perform a cost and producibility analysis, up front, to predict if it is feasible to fully develop and produce the technologies. Conduct modeling and simulation to predict the performance of selected candidates under realistic conditions. Fabricate breadboards and perform laboratory tests on them to confirm the predictions of the models. Submit samples to the Government for in-house evaluation.

PHASE II: Implement technology from Phase I effort into actual fuze hardware. The fuze hardware will be evaluated by subjecting it to standard fuze laboratory environmental and ballistic simulation tests. If lab tests are successful, another set of fuze samples will be fired from a weapon in an instrumented ballistic field test. The prototype designs shall be optimized for producibility and cost. Detailed design drawings and specifications shall be developed.

POTENTIAL COMMERCIAL MARKET: Fuzing sensors are inherently low-cost and precise standoff sensors that can provide position, velocity and acceleration outputs. These have a wide variety of commercial applications including: accurate altimeters for the last 100 meters of approach to the ground for helicopters and light planes; crash avoidance and backup sensors for

automobiles and minivans; measurement of true velocity and distance traveled for accurate application of agricultural chemicals and seed; motion detectors for alarm systems; and position/motion sensors for robotic and automated industrial systems.

A96-016 TITLE: Rapid Container Blocking and Bracing Technology

CATEGORY: Exploratory Development

OBJECTIVE: Develop a technology that will enable the Military to block and brace munitions and supplies in containers and MILVANs rapidly to meet early entry force deployment and force sustainment requirements.

DESCRIPTION: The existing method of Blocking and Bracing munitions and supplies in containers and MILVANs requires lots of wood and is labor intensive. Many military installations do not have the personnel to block and brace munitions and supplies in containers or MILVANs because of the special skills requirement. The wood used to block and brace munitions and supplies in containers and MILVANs usually cannot be reused because of damages or configuration problem. Sometimes the required wood may not be available. The existing method creates a dilemma during deployment or retrograde of munitions and supplies. A technology is needed to improve the blocking and bracing method. The technology shall be capable of restraining supplies with various configurations at rapid speed, durable, user friendly, reusable and environmental friendly; meet transportation requirements; and at a cost comparable to the existing method.

PHASE I: Investigate new and innovative blocking and bracing materials and systems used by the shipping industry. Based on the investigation, develop a system design that can be used to block and brace military munitions and supplies. The system shall meet the design criteria specified in the DESCRIPTION paragraph above.

PHASE II: Develop and fabricate prototype test hardware for the Rapid Container Blocking and Bracing system. Coordinate with the Government Project Officer to develop a test plan, and conduct testing to verify the system. Develop a performance specification, operation instruction and unit cost. Submit monthly and a final report.

POTENTIAL COMMERCIAL MARKET: The technology developed under this program can be used by the container shipping companies. The system will enable the shipper to block and brace cargoes at reduced time and cost.

U.S. Army Research Laboratory

A96-017 TITLE: Low-Frequency, Ultra-Wideband (UWB) Synthetic Aperture Radar (SAR) Antennas Compatible with Unmanned Aerial Vehicles (UAV)

CATEGORY: Basic Research

OBJECTIVE: Design and development of low-frequency, ultra-wideband antennas of a size commensurate with the size and weight restrictions of an unmanned aerial vehicle.

DESCRIPTION: Detection of concealed, time critical targets is a military need for which there is no current fielded solution. The Army Research Laboratory Microwave Radar Branch is investigating low frequency UWB SAR for the detection of targets concealed underground or by foliage. One of the major hardware limitations of ground and foliage penetration technology today is the size of the antennas required to get the low frequency content and wide bandwidth necessary. The radar design currently being pursued requires antennas with a frequency coverage from 50 MHz to 1000 MHz. The antennas must have a peak VSWR of less than 2.0. with a goal of 1.5 or less, over the entire frequency band. The antennas must have a polarization isolation between co-polarized and cross- polarized channels of at least 20dB within a 35 degree solid angle centered on boresight, and no worse than 15 dB of isolation over a solid angle from 35 to 60 degrees centered on boresight. The radar must be capable of transmitting and receiving the full polarization scattering matrix. The antennas must be capable of transmitting peak powers on the order of 10MW and average powers of 5-10 Watts. The antennas must be designed to be compatible with the size and weight restrictions of a TIER II UAV.

PHASE I: The offeror shall perform study of low-frequency, wideband antenna designs to identify potential solutions. The offeror shall produce a design drawing and specifications for an antenna that meets the requirements stated above. The offeror shall prepare a report including calculations and/or modeling used to develop the design of an antenna meeting the above requirements.

PHASE II: The offeror shall finalize an antenna design, construct a full set of antennas (covering the full scattering matrix), and completely characterize the antennas.

POTENTIAL COMMERCIAL MARKET: There are a large number of commercial applications for low-frequency, UWB radar. Utility companies are interested in methods to non-intrusively locate wires and pipes underground. Construction companies need non-intrusive methods of inspecting roads, bridges, and railroad beds for internal faults. Site remediation firms, performing base closure impact area clean-up for instance, require a ground as well as foliage penetration capability.

A96-018 TITLE: Millimeter Wave Solid State Power Device/ Component Development

CATEGORY: Advanced Development

OBJECTIVE: To study, develop, and demonstrate technology and approaches to power generation at Millimeter Wave frequencies (>30GHz) to replace large, high voltage, and less reliable vacuum tube amplifiers.

DESCRIPTION: New military and commercial requirements are emerging for high power transmitters in the millimeter wave band. Several examples include tactical radars, radar electronic countermeasures (ECM), satellite communications, collision avoidance radars, and high data rate communications. Advances in solid-state device technology in the form of High Electron Mobility Transmitters (HEMTs), Heterojunction Bipolar Transistors (HBTs), and Microwave Millimeter wave Integrated Circuits (MMICs) have moved the concept of a reliable, high power, solid-state millimeter wave transmitter closer to reality. The current challenge is combining large quantities of these devices efficiently and reliability to achieve tens of watts of output power. The objective of this project is to develop and demonstrate a practical approach to realize a high power solid state millimeter wave transmitter/amplifier by combining a large number of moderate to high power devices.

PHASE I: Study and develop a millimeter wave power source/amplifier design that addresses reliability, cost, size, and performance using state-of-the-art components and analyze for optimum power combining technique, low-loss, heat dissipation, etc., to achieve the program goals. Suggested performance goals of the Phase I effort are minimum 20 watts CW at Ka-band, 10 watts at V-band, and 5 watts at W-band and the final transmitter/amplifier design suitable for flight testing as part of an electronic warfare/electronic countermeasure (EW/ECM) system. The effort will consist of the transmitter/amplifier design, and will include device selection, power combiner design, combiner interfaces (waveguide, microstrip, probe, microcoax), and prediction of performance such as insertion loss and gain, VSWR, and performance degradation due to phase/amplitude tracking and device failure.

PHASE II: Fabricate, test and deliver the transmitter/amplifier designed in Phase I. A final documents package should be delivered that includes final schematics and drawings, a test plan for the transmitter, test results of the individual modules and combiner/power splitter, and test results of the fully integrated and tested unit. A simple reliability analysis should be performed to provide an approximate prediction of Mean Time to Failure (MTTF), Mean Time Between Failure (MTBF), etc. of the final transmitter. Also a thermal analysis should be performed to ensure adequate heat dissipation and structural integrity of the module. All DC biasing capabilities, voltage sources and turn-on sequencing, will be included in the final module delivery.

POTENTIAL COMMERCIAL MARKET: This technology can be applied to military and commercial communication systems, satellite links and to the emerging commercial cellular video and automotive collision avoidance markets. The high frequency enables wider operational bandwidths thus permitting more data/information to be processed. This is important for high data rates and video information especially since the lower frequency bands are highly congested and limit the frequency band of operation.

A96-019 TITLE: High Performance Imagers with On-chip Processing

CATEGORY: Exploratory Development

OBJECTIVE: Demonstrate feasibility of performing on-chip signal processing functions on high performance silicon-based imagers using CCD or CMOS technology as appropriate.

DESCRIPTION: Performance of high speed, large format imagers can be significantly enhanced by providing image processing functions on chip. In particular it may be possible to reduce data rates, identify regions of interest, selectively readout the

imager for higher speed operation, and perform linear and nonlinear signal processing functions. This research topic concentrates on the incorporation of signal processing functions onto the readout structure of existing or future imagers.

PHASE I: Perform feasibility study to identify proper mix of signal processing to be incorporated on chip and identify chip architecture. Demonstrate on a small scale the manufacturability and operation of such a chip.

PHASE II: Design large scale chip 512 x 512, 1024 x 1024, or larger incorporating signal/ image processing functions of chip and produce a selection of these devices.

POTENTIAL COMMERCIAL MARKET: High performance imagers with on chip processing will have applications in fields including HDTV, Medical Imaging, Film replacement in high speed motion analysis equipment, machine vision, etc.

A96-020 TITLE: Multi-functional Thin Film Biomatrices for Biosensors

CATEGORY: Exploratory Development

OBJECTIVE: To research and develop surface matrices as media for biological/ biochemical reactions in micro-sensor applications.

DESCRIPTION: There is a need for the development of biomatrices for use to interface biological/ biochemical reactions with appropriate sensor substrates. The requirements of a matrix are that it should retain high specificity for the intended biomolecular interactions and simultaneously allow signal transduction via the interfacial surface to the sensing mechanism. The matrix should be stable, portable and robust. Conferring functionality to the substrate device may involve covalent bond formation or non-covalent interactions.

PHASE I: Show proof of principle by providing a model surface matrix system. The offeror should show matrix properties, their characterization, and the retention of the desired biological/ biochemical specificity.

PHASE II: Adaptation of the surface matrix system development under Phase I to existing appropriate micro-sensor surfaces. Expansion of the detector system for two or more biological/ biochemical reactions or interactions. Optimize the prototype surface system to give high degree of precision, reliability and ruggedness.

POTENTIAL COMMERCIAL MARKET: The technology developed under this program should have extensive application in the environmental and medical diagnostic industries.

A96-021 TITLE: Digital Optic Image Acquisition with Enhanced Performance

CATEGORY: Advanced Development

OBJECTIVE: Develop digital signal processing and hardware designed to work in conjunction with custom aspheric optics in order to improve visible and infrared image acquisition systems.

DESCRIPTION: Image acquisition systems can be enhanced by combining custom optics in conjunction with digital signal processing (DSP) to improve overall system behavior. As an example, the field of view of an optical system can be extended by using a wide angle lens in conjunction with DSP to correct for the added distortion. Without the post digital correction, objects in the periphery of the field of a very wide angle lens are distorted beyond recognition. The DSP compensates for the distortion to make the object recognizable. As a second example, a cubic phase optical element can extend the depth of field of a system when used in conjunction with specialized DSP. Without the digital correction the imagery produced by the cubic system has a large depth of field, but fine featured objects are difficult to discern. The DSP is designed to compensate for the negative effects on the system behavior while maintaining the high depth of field. In both of the above examples, the enhanced performance cannot be easily achieved with only improved optics or only DSP. Rather, the use of the optics in conjunction with DSP enables a new level of performance.

This research topic concentrates on the development of DSP algorithms tailored to work in conjunction with custom aspheric elements to extend the operating characteristics of image acquisition systems. The algorithms should be adaptive in nature to take into account the characteristics of available image sensors. Improved algorithms for the above mentioned extended depth of field and extended field of view systems are of special interest. Entirely new imaging architectures using custom aspherics in conjunction with DSP will also be considered.

PHASE I: Specify the digital optical architecture and the nature of the expected imaging system enhancement (e.g., increase depth of field, extended field of view, increased tolerance to vibration,...). Develop optimized signal processing algorithms that take into account the need for real time implementation as well as the characteristics of available image sensors.

PHASE II: Design and build real-time hardware implementations of the algorithms developed in Phase I. Integrate the hardware with the associated optical imaging system and demonstrate overall system performance.

POTENTIAL COMMERCIAL MARKET: Enhanced digital image acquisition systems have the potential to play significant roles in consumer digital cameras (both still and video), machine vision, and medical imaging applications.

A96-022 TITLE: Loom for Weaving Single Layer Net-Shape Fabrics for Composite Structures

CATEGORY: Exploratory Development

OBJECTIVE: The primary objective of this effort is to develop a fully automated computerized loom capable of weaving net shape single layer fabrics that have tailored fill yarn fiber orientations as well as in plane and out-of-plane curvature.

DESCRIPTION: Current production costs of continuous fiber reinforced composite structures are in excess of $100 per pound. However, technology has been developed within the Government that will greatly reduce these costs. Through the use of canted and adjustable reeds it is possible to tailor fiber orientation of the fill yarn in a fabric. Fabric width can be controlled by changing the location of the warp yarns. Curvature in the fabric is achieved by differential takeup of the warp yarns. It is the objective of this effort to incorporate these technologies into a fully automated computerized loom. This loom will be suitable for producing high quality fabric for creating preforms used in the formation of composite structures. It is anticipated that the loom will operate at several hundred fill insertions per minute requiring minimal operator interaction while weaving.

PHASE I: A computerized loom shall be modified to incorporate differential fabric to demonstrate independent takeup control of each warp yarn. The loom shall be delivered to the Government for evaluation.

PHASE II: Modification to the loom shall be made to accommodate tailored fill yarn orientation and tailored fabric width in conjunction with the differential fabric developed in Phase I. This loom shall incorporate state of the art fill insertion techniques to achieve the high speed operation. The loom shall be delivered to the Government for evaluation.

POTENTIAL COMMERCIAL MARKET: This loom has vast potential applications to military and civilian structural applications. As the cost of fabricating composite structures decreases the potential market for this technology will increase.

A96-023 TITLE: Artificial Intelligence Enhanced Information Processing

CATEGORY: Basic Research

OBJECTIVE: This topic solicits research in advanced information processing algorithms as well as hardware architectures focussed on situation awareness and assessment which will support critical Army program areas such as fusion stations, ground stations, C4I workstations and advanced robotic platforms.

DESCRIPTION: The Army has a strong continuing interest in real-time information processing research for inclusion as a next generation C4I workstation. Information processing includes those operations normally performed after signal processing, thus relating to higher levels of abstraction than those addressed by signal processing. Because there will be a plethora of information available to these processing stations, the development of effective algorithms, autonomously fusing this information and supporting situation awareness and assessment software agents which alert human operators and other software agents, is a necessity. Applicable research should relate to high-speed information processing (particularly with AI based enhancement). This topic includes advanced processing architectures (scalable) as well as advanced algorithms.

PHASE I: Innovative algorithms and advanced processing architectures are sought, that improve situation awareness and assessment.

PHASE II: Research resulting in real-time implementation of Phase I algorithms and processing architectures which will show direct relevance to an objective interest area such as fusion stations, ground stations or battlecommand workstations.

POTENTIAL COMMERCIAL MARKET: The technologies related to this topic, Artificial Intelligence Enhanced Information Processing, correspond strongly with a number of commercial or dual-use applications such as aircraft tracking and control for commercial airfields and intelligent highway system applications.

A96-024 TITLE: Parallelizing Visualization Algorithms for Interactive Computational Analysis

CATEGORY: Exploratory Development

OBJECTIVE: To develop an integrated package of software tools using parallel computing techniques capable of interactively visualizing very large datasets using state-of-the-art Department of the Defense High Performance Computing (HPC) assets.

DESCRIPTION: An on-going problem for the scientists and engineers is the ability to interactively investigate and visualize the data produced from calculations run on high-end parallel supercomputers. Commercial software vendors have not yet taken the lead in developing advanced techniques to replace traditional, sequential visualization software.

The advent of reasonably affordable parallel computers configured as symmetric multiprocessors will, in the near future, enable advanced government and commercial research groups to perform computational analysis on grids consisting of several million nodes. Unfortunately, the ability to generate these massive datasets has outstripped the ability to visualize them. Many of the algorithms underlying popular visualization techniques are as computationally complex (in both memory and CPU) as the initial analysis. Although batch methods can be used to generate images from very large datasets, productive visualization is inherently an interactive process.

The most attractive option to break the visualization bottleneck is to employ the same techniques used to generate the data: parallelization. Although some efforts have been made to implement parallel algorithms for various visualization tasks, these efforts have been narrowly focused and restricted in application. There currently exists no commercial, general-purpose visualization package that can be used to productively postprocess these extremely large datasets.

The areas of innovative technical development proposed under this project would include: 1) the development, implementation, and evaluation of parallel algorithms (using both task and domain decompositions) for performing various visualization tasks such as particle tracing, isosurface generation, and clipping and cutting calculations. 2) the evaluation of state-of-the-art parallelization strategies such as, but not limited to, shared memory, PVM, and MPI, as a mechanism for applying parallel computing techniques as a postprocessing solution for datasets that are too large to be handled on a single machine. 3) taking advantage of the resulting performance improvements to yield real-time, interactive response for certain operations, such as particle tracing and streamlines, cutting planes, and isosurface calculation.

The main deliverable from this project is robust interactive scientific visualization software which contains parallel algorithms for various tasks which is supported, general-purpose, and portable to a variety of commercially available parallel platforms. In order to promote widespread adoption and usage, this solution would be presented as an integrated, interactive and portable commercially viable product.

PHASE I: Initial development should focus on the evaluation and implementation of a variety of HPG techniques for parallelizing existing visualization algorithms, such as particle traces, streamlines, cutting planes and isosurface generation. These techniques would be evaluated against particularly large, multi-grid datasets.

PHASE II: The second phase of work would incorporate these techniques into a single, integrated, interactive visualization package. The implementation would include a single, cohesive user interface typically associated with graphics applications run on a high-end graphics workstation. The expected interaction between the end-user and the application would typically include, but not be limited to, an implementation of a client-server architecture to connect the end user's workstation to the parallel computing platform where the visualization software is running.

POTENTIAL COMMERCIAL MARKET: Significant. The dual-use impact for government and industry of such parallel visualization software support by a commercial vendor would be significant and immediate. The development of such software would have a wide and immediate impact in the U.S. research and development community since this technology is applicable throughout the entire domain of computational analysis, including computational fluid dynamics, computational structural mechanics, combustion modeling, and electromagnetics. The advent of a portable, parallel commercial visualization package with the ability to handle very large datasets should significantly increase the productivity of advanced users.

A96-025 TITLE: Information Assimilation Error Measurement for Digital Displays

CATEGORY: Basic Research

OBJECTIVE: The objective of this effort is to develop and validate a quantitative method for identifying, defining, and classifying recurrent patterns of soldier operator error associated with the assimilation of text and graphics information from visual displays (e.g.,flat panel CRTs, head mounted displays).

DESCRIPTION: A critical process in the soldier-information system interface on the digital battlefield is the soldier's assimilation of critical text and graphics data from the proliferation of digital displays that are being incorporated into future weapons systems and C2 systems. For this process to be conducted successfully, the soldier must be able to rapidly and accurately focus on critical elements of information embedded in a vast stream of digital data expected to flow across the digital battlefield. Often, this process will be conducted within a highly stressful environment involving varying lighting conditions, high noise, vehicle motion, and display vibration. Combining high information volume with a stressful interface environment is expected to produce various error chains that can manifest themselves as poor situation awareness, misinterpretation of events and operational trends, decision delays, and fratricide. While such issues can be addressed in the design of tactical displays, engineers generally lack a detailed understanding of these recurrent error chains and their relationship with specific display characteristics. The proposed effort takes an initial step in furthering this understanding by developing a quantitative method for: 1) systematically observing the soldier's process of rapidly assimilating text and graphics information under stressful conditions, 2) developing a taxonomy of the recurrent error patterns associated with this process, and 3) quantifying the relationships that exist among these error patterns and specific characteristics of the visual displays.

PHASE I: An initial effort consists of a series of systematic observations of the soldier-information system interface conducted within one or more Advanced Warfighting Experiments (e.g., Warrior Focus, Focus Dispatch). As part of these observations, the research will employ the critical event method to document significant error chains associated with the soldier's ability to rapidly and accurately assimilate critical items of information form various digital display devices being used in the experiments. By identifying common elements of the error chains across different display systems and tactical environments, the research will develop the major product of Phase I: a preliminary taxonomy of error patterns associated with digital information assimilation in a stressful environment.

PHASE II: Using the error taxonomy developed in Phase I, the research will develop and validate a quantitative method for assessing assimilation error rates in future experiments. The research shall consider a variety of standardized measurements methods, including, but not limited to, behavioral checklists, behavioral observation scales, and subject matter expert rating scales. The candidate measurement method will be validated in the context of a second series of Advanced Warfighting Experiments by collecting the appropriate error ratings and testing the statistical significance of their relationship with other measures of soldier-system effectiveness.

POTENTIAL COMMERCIAL MARKET: The quantitative method for assessing digital information assimilation error rates has broad applicability to the commercial computer market. As computer hardware-software applications extend to a broader range of work situations involving stressful environments, such methods will be essential for the proper design and testing of tactical information displays. By developing a standardized error taxonomy and associated rating scales, the research contributes to the development of industry design standards for text and graphic displays.

A96-026 TITLE: Virtual Reality Battle Management Tool for C3 Nets

CATEGORY: Exploratory Development

OBJECTIVE: Adapt a technique developed by British Telecom (BT) to render a C3 network and its status in virtual reality superimposed on a terrain map. This technique would be invaluable in designing and optimizing the complex data network needed for "digitization" and for real-time battle management of an interactive combat network extending over any number of echelons and types of nets.

DESCRIPTION: Terrain is represented either in platform (2 dimensional) or in 3 dimensions with variable viewpoint (stealth platform) for perspective from a given point in space. The terrain can be represented with conventional, fixed detail or by the variable resolution methodology developed by WTD. The nodes are represented by icons superimposed on the terrain. The icons can be of different colors and shapes to represent different types of node equipment. The links can be represented as colored bands of different thickness depending on type of link and traffic capacity and actual traffic. Status of nodes and links

in terms of message delay, message throughput, and message loss can be represented by some visual representation such as bar graphs of different color and height. Per cent capacity can be represented in proportion of bar graph that is black or some neutral color.

Data links and voice nets can be adapted to this idea. The technique is not limited to number or types of units, given the operators ability to concentrate on any combination of nets, and the ability to tailor data displayed during use. The operator or analyst can then use a flat display or virtual reality goggles to "fly" about the net, examining its status in real time. Such a scheme would allow analysis of digital or analog message or data flow in a tactical net, with traffic perhaps represented by thickness or intensity of the line connecting nodes, message delay by vertical column, net function by color (fire control being red, infantry tactical by blue, logistical by purple, etc.). The analyst in peacetime could assess quickly the performance of a tactical array as a simulated battle progressed, or a battle command manager could, given status reporting by the net elements, actually manage communications in the presence of battle damage, real terrain effects, or ECM, and manage the net to minimize enemy effects and optimize the net performance. For instance, dead ground could be visualize to use terrain masking or antenna sitting to minimize enemy intercept. In a digitized net operating under internet protocol and structure the status of the net would be apparent to battle manager in real-time, allowing work arounds to compensate for battle damage, jamming or virus attack.

PHASE I: Analysis the net types and net status information available to 1) a simulation manager and 2) a battle manager of a digitized force.

PHASE II: Based on any of the terrain visualization methodologies now in use, construct a modular software package to allow superposition of net information.

POTENTIAL COMMERCIAL MARKET: Develop a marketable tool for network management. Care must be taken to either adapt under license the BT package or avoid infringing upon patented or proprietary methods used by BT

A96-027 TITLE: Induction Bonding of Composite Armor

CATEGORY: Advanced Development

OBJECTIVE: Development and demonstration of a procedure for bonding of thermosetting polymer composite armor structural parts using diffusion enhanced adhesion and induction heating technologies.

DESCRIPTION: Diffusion enhanced adhesion (DEA) is a process which enables thermoplastic (TP) like fusion bonding of thermosetting composites. In this process, a thermoplastic layer with similar solubility to the TS is co-molded to a thermoset (TS) based composite adhered using a processing technique in which the TP polymer molecules move across the TP-TS interface and entangle with the TS polymer chains prior to complete crosslinking. Upon full crosslinking of the TS polymer, a very strong interface has developed between the TS based composite adherend and the thin TP polymer surface layer. Using this procedure, TS based composites can be fusion bonded using a variety of methods including resistance welding and induction bonding. Induction heated bonding of composites consists of the heating of an interlayer susceptor (such as metallic screen) and the subsequent melting, flow, consolidation under pressure, and bonding of two TP based adherends. The DEA process makes this adhesion technique available to thermosetting polymer based composites since the TS based composite has TP polymer layers on the surfaces to be bonded.

PHASE I: Demonstrate diffusion enhanced adhesion (DEA) and induction heating as a process for joining thermoset based armor composites. Characterize bonding strength and assess cost-related issues relative to other TS composite joining techniques.

PHASE II: Utilize DEA and induction heating in a process to fabricate a TS based composite structure. Demonstrate adaptability to a variety of TS based composite armor structure bonding requirements including thick section, production, and repair. Assess a variety of TS-TP DEA compatible resin systems.

A96-028 TITLE: Intelligent Wire Bond Pull Station for Microelectronics

CATEGORY: Advanced Development

OBJECTIVE: This project develops a new generation of bond pull station by combining state-of-the-art optics, machine vision, strain gauge, high speed transport systems and bond pull technologies. This system will have the intelligence and imbedded knowledge of a skilled human operator which will : 1) Automatically search and identify bond wires in microelectronics

assemblies with high speed, precision and reliability with no up front set-up efforts to the station; 2) Require no per-programming and verifying of unique part characteristics before each bond pull sequence; 3) Determine and optimize precise location of bond pull site for each wire with no human intervention; and 4) Perform bond pull automatically and document results for Statistical Process Control. The results of this effort will be beneficial to both the military and commercial microelectronics manufacturing arena.

DESCRIPTION: Bond pull testing is a necessary methodology for testing the integrity of wire bonds for microelectronics assemblies. The use of this methodology on military hardware has increased dramatically in resent years and has created concerns with the added labor, throughput delays and precise execution of this process. Most of the bond pull equipment are manual which requires the operator to position the bond hook under each wire prior to the pull test. The semi-semi-automated system requires pre-programming and dry running of the pull sequence prior to pull testing each assembly. This pre-programming and dry running effort is due to the unpredictable tracking characteristics of the bond wires when they were assembled. A new generation bond pull tester which will respond to the unique characteristics of a microelectronics assembly in real time will be developed under this project. Innovative techniques using a combination of the latest sensor based manufacturing technologies and intelligence is expected to be used.

PHASE I: A study and an innovative concept to investigate the feasibility for a totally hands off intelligent bond pull station. This concept must be technologically feasible and meet the objective of reducing hardware system costs, material handling cost, set-up cost, programming time and manufacture throughput time.

PHASE II: Prototype of the intelligent bond pull station outlined in Phase I will be designed and built using the most advanced technologies available. Deliverable would include a complete design analysis, a design documentation package, and a prototype station suitable for test and evaluation, using microelectronics assemblies supplied by the Army. The contractor shall participate in the evaluation test to guarantee the system is working at full capability and provide timely modification as needed to optimize system performance.

POTENTIAL COMMERCIAL MARKET: Low cost production units are planned to replace the manual and semi-automatic systems being used in industry today.

A96-029 TITLE: Machine Translation of Battlefield Messages

CATEGORY: Exploratory Development

OBJECTIVE: Identify approaches to machine translation that adequately address the domain of Army Command and Control systems and that can be easily be extended to the variety of languages encountered in coalition operations. Select typical restricted-domain battlefield messages (e.g., operations orders with some structure imposed on the information). Build a parser and machine translation system to accommodate those messages.

DESCRIPTION: The Information Science and Technology Directorate is leading the Army Research Laboratory's (ARL) Digitization and Communications Science trust. One aspect of the digitization effort is the development of methods for providing data for warfare (and operations other than war) to the soldier in a manner that can be readily assimilated and used. On today's battlefield of multi-lingual coalition forces, rapid translation of information from one human language to another is a requirement for total situation awareness. However, current machine translators lack the sophistication and speed required to guarantee understandable information is provided in a timely manner to intended recipients.

PHASE I: A six month effort might produce deliverables similar to the following: analysis of approaches to major technical challenges (e.g., understanding semantics and pragmatics of natural language): identification of restricted language required for battlefield communication of messages in the Command and Control infrastructure; initial development of lexicons and rules to support robust coalition translation techniques; concept demonstration of an automated translator from English to a selected second language.

PHASE II: A two-year effort might address aspects similar to the following: a prototype English to second language translator; coordination with an ARL testbed to further explore machine translation concepts on restricted domains associated with actual Army systems; development of approaches to evaluation of machine translation systems (e.g., with regard to utility and quality; development of approaches to automated extraction of information from variable format text and discourse summarization; interface with collaborative research involving unification of standardization efforts involving command and control message elements; initial interface to applications (e.g., selected ATD products).

POTENTIAL COMMERCIAL MARKET: This work has enormous potential for improving military C3 and analogous civilian systems. Careful tuning of software to specific missions could improve the quality and timeliness of current machine translation programs. Because language is best evaluated by native speakers, machine translation provides an ideal quid-pro-quo opportunity for research with our allies. Beneficiaries could include any industry requiring international communications and databasing.

A96-030 TITLE: Information Processing Applications for Cooperating Microrobotics Systems

CATEGORY: Exploratory Development

OBJECTIVE: This topic solicits exploratory development in hardware and software architectures which will support critical Army application areas for cooperating microrobotic systems in tactical and operations other than war scenarios. Microrobotics in this application is defined as autonomous or semi-autonomous physical agents with linear dimensions of one or two feet.

DESCRIPTION: The Army has a strong continuing interest in real-time hardware and software architecture development for application to microrobotic Army systems having reconnaissance, surveillance, and target acquisition (RSTA) as their primary mission. Sensors, (acoustic, IR and visible) processing and communications will be embedded on these platforms. Applications to cooperating physical and software agents involving both stationary and moving platforms are the main focus of this topic. Examples of information processing in this area are multi-perspective data fusion, target tracking, and situation awareness. Applicable topics should relate to high-speed information processing. This topic includes advanced processing architectures (scalable) as well as advanced algorithms.

PHASE I: Exploratory development of information processing techniques as applied to the RSTA mission for multi-agent cooperating platforms. Developed algorithms are then validated by simulation to be real-time on an advanced processing architecture.

PHASE II: Extension of Phase I processing techniques and computation architectures to multiple (at least two) platforms. Quantitative evaluations must show gains in target acquisition, tracking, and analysis through the use of cooperating agents.

POTENTIAL COMMERCIAL MARKET: The techniques related to this topic correspond strongly with a number of commercial or dual-use applications such as aircraft tracking, vehicle control in the intelligent highway program, and physical security systems.

A96-031 TITLE: Integrated Soldier Interface for Hands-off Control of Head Mounted Display Information

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate a head mounted display (HMD) system which can be controlled "hands-off". Information would be called-up and displays changed using verbal commands, and editing or menu control accomplished by eye tracker input. An entire military scenario could be accomplished, using the HMD as the primary soldier interface device, without manual inputs of any type.

DESCRIPTION: Helmet or head-mounted display systems, already common in aviation settings, are now proposed for mounted and dismounted soldiers, for tele-operation of unmanned vehicles, and for tele-maintenance and tele-medicine applications. To realize the maximum potential of these highly portable devices, the users must be provided with a means of interacting with the displays without using their hands. A dismounted soldier using an HMD needs his hands for his weapon; a tank commander or scout using an HMD will need to change the information displayed as the mission evolves without the diversion of entering manual commands at a control console. Voice control offers a natural way to request information to be displayed and some systems under development use this approach. There are many situations, however, where voice control will not be effective. Other technologies such as eye tracking should be applied to permit these display systems to reach their full potential.

PHASE I: A integrated voice control and eye tracking system would be used to control information presented on a head mounted display, but processed by a standard desktop computer. At this point, head weight, equipment volume, and center of gravity would not be important considerations compared to the overall hands-free function of the system.

PHASE II: At the end of the second Phase, a totally portable HMD system would be demonstrated which would feature hands-off control of the information presented, even in high noise, high motion environments. The head mounted portion of the system would be light weight, compact, and fall within acceptable center of gravity limits.

POTENTIAL COMMERCIAL MARKET: The same reasons which make HMD's so attractive for military applications will propel them into wide use in the commercial sector. Likewise, these commercial systems will be most useful if the operator can control the information displayed while keeping the hands free to perform other functions. Mechanics and electricians, for instance, could change the information content of their displays continuously as they progress through the stages of a certain procedure. Physicians could request vital signs or medical information including stored images while in the midst of performing surgical procedures. A hands-off method of controlling information display would be quite beneficial to many physically challenged people and could be their key to entering the work force.

A96-032 TITLE: Laser Cross Wind Sensor

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate a compact, lightweight, rugged and eye-safe wind sensor capable of measuring cross wind profiles for ballistic wind corrections.

DESCRIPTION: Cross wind, the component of the wind vector perpendicular to the line-of-fire is the largest component in the error budget for sniper weapons used to engage targets at long range. Current technologies to estimate cross wind (and thus the required aim point correction) rely on visual cues (such as the motion of foliage) or on a point measurement of the wind at the shooter's position (from e.g., an anemometer). The cross wind is also assumed to be constant between the shooter and target. These estimates for cross wind deflection are often inadequate. To overcome this deficiency, an innovative laser system is sought that can make real time measurements of the cross wind as a function of distance to a range of 1500 M, with an accuracy better than 1 M/S. The range wind component is also desired but not required. The physical dimensions and function of the system should be compatible with sniper operations, i.e. compact, lightweight and rugged. The system should meet laser eye safe standards. The ability of the sensor to also measure range to target is a very desirable feature.

PHASE I: Concept Validation: Through laboratory and field tests, demonstrate the ability of the employed sensor technology to achieve the measurement performance outlined in the description.

PHASE II: Prototype System Development: Design, fabricate and test a prototype system. Demonstrate the ability to meet performance, size, weight, and packaging requirements. Develop a manufacturing plan for high volume low cost production.

POTENTIAL COMMERCIAL MARKET: A low cost, compact, rugged, eye-safe wind sensor has potential application for law enforcement agencies, for the aviation market as a wind shear and turbulence detector, for the sports market in competitive shooting and sailing and for sensing drift of pollutants.

A96-033 TITLE: Display Device Development

CATEGORY: Exploratory Development

OBJECTIVE: This program should address one or all of the following areas for improved functionality for display devices: luminance, color, efficiency, size, resolution, environmental limits, viewability, 3-D viewing.

DESCRIPTION: In the area of light emitting structures and materials for display applications; programs are sought that involve novel devices, methods of preparation, and techniques for the evaluation of materials, films, and structures, a better understanding of the physical processes in display devices, reductions in complexity and/or cost of manufacture. Research leading to ultra low power drive schemes for emissive displays. Significant power is wasted in the drive method, the addressing circuitry and in A-D/D-A converters and video RAM. The effort should include new innovative drive techniques to minimize losses in the display as well as in the drive and associated image processing circuitry. Various applications require growth of display capabilities to larger sizes and higher resolutions for group viewing, high information content, and in some cases stereo for depth perception. Innovative methods for combining images to create displays beyond the size of substrates which can be readily manufactured are of interest. For stereoscopic displays, approaches which do not require the use of glasses are more suitable for military applications.

PHASE I: Develop a selected display device concept through analysis of potential performance and advantages and an evaluation of the feasibleness of proposed fabrication methods. At the end of Phase I, a report of the device design, performance assessment and a description of proposed fabrication methods and issues should be delivered to the government.

PHASE II: Fabricate, evaluate and demonstrate the device concept developed under Phase I.

POTENTIAL COMMERCIAL MARKET: New display technologies are exploding into the marketplace, since they represent the information window between people and the engines of the information age. Technical improvements in any given technology greatly improve its competitiveness in this rapidly growing field.

U.S. Army Research Office

A96-034 TITLE: Innovations in Optics Manufacturing

CATEGORY: Basic Research

OBJECTIVE: Develop new and innovative material and processing approaches to the manufacturing of optical elements and systems.

DESCRIPTION: Identify innovative concepts that offer the potential for radically altering the design and manufacture of optical components. The emphasis is on finding new technologies that afford significantly improved system performance and reduced costs with respect to the current state of the art. Processes that are amenable to flexible manufacturing approaches and small batch acquisitions, especially those that make full use of computer integrated design and engineering concepts, are strongly encouraged. Hence, proposals may involve the demonstration of new materials and processing alternatives, the incorporation of critical material processing characterization techniques for in -line process control. Areas of general interest include: 1) surface-relief diffractive elements and related hybrid optics; 2) refractive gradient index lenses; 3) non-light-emitting components used in flat panel and projection display technology, including IR scene projection; 4) microlenses and lenslet arrays; 5) reflective (UV and X-ray) optical elements, and 6) optically or electrically switchable elements.

PHASE I: Investigate and demonstrate feasibility of innovative approaches to the manufacture of optical elements that will significantly improve performance or reduce costs in relation to present state-of-the-art materials and approaches.

PHASE II: Implement the innovation, which may include the design and testing of prototype systems. Explore major cost and reliability issues associated with the innovation in the context of commercial viability.

POTENTIAL COMMERCIAL MARKET: Optical components are critical elements in a multitude of commercial and military systems including: cameras, CCD video cameras, CD optical storage players, laser printers, photocopiers, computer displays, simulators, photolithography, optical interconnects, telecommunications and noninvasive medical procedures. This research is intended to introduce breakthrough technologies (new capabilities, enhanced performance, and reduced system size and weight) that significantly reduce system costs.

A96-035 TITLE: Chemical Hydride Hydrogen Sources for Small Fuel Cells

CATEGORY: Basic Research

OBJECTIVE: Develop a chemical hydride-based, compact hydrogen source to provide high grade hydrogen to small fuel cell power supplies.

DESCRIPTION: The Army has an ongoing program to develop small (20 watt to 1000 watt) fuel cell power supplies. The development program has made excellent progress in improving the power density of small hydrogen/air fuel cell stacks; however, lack of a safe, reliable, high energy density hydrogen supply is a major impediment to fielding these new power supplies. The Army has explored a number of different approaches to hydrogen sources; the most promising approach to hydrogen supplies containing a few hundred to a few thousand watt-hours of energy appears to be hydrogen generators based on chemical hydrides such as (but not limited to) lithium borohydride or sodium borohydride.

PHASE I: Demonstrate production of hydrogen equivalent (50% efficient fuel cell stack) to several hundred watt-hours from a chemical hydride using a lightweight reactor. The reactor shall be engineered to afford a high degree of safety to the user in the event of a reactor malfunction. The hydrogen source should tolerate being turned on and off several times during the consumption of the chemical hydride. Heat fluxes within the system must be characterized in sufficient detail to permit a meaningful phase II proposal.

PHASE II: Scale up the reactor system developed under phase I to produce hydrogen equivalent (50% efficient fuel cell stack) to 1200 watt-hours from a system weighing less than 2.2 Kg. The system should be attitude insensitive, and should be easy to wear or carry in a pack. The design shall demonstrate concern for user safety. The systems controls should be operable by a use who is wearing gloves. The system should be designed to show that the charge of fuel can be quickly and safely replaced. The final demonstration shall require the hydrogen supply to power a small fuel cell stack.

POTENTIAL COMMERCIAL MARKET: The commercial market for small power sources is growing at a very rapid rate. Laptop computers, cellular phones and other communication devices, and various recreational applications require power levels toward the lower end of the Army's small fuel cell power range. Cordless power tools and more intensive recreational power users require higher levels of power.

A96-036 TITLE: Milli-Robotics for Remote, Minimally-Invasive Surgery

CATEGORY: Basic Research

DESCRIPTION: Medical telepresence/teleoperation technologies are essential for many Army and civilian needs, such as delivering fast medical/ surgical help to critically injured soldiers on the far-forward battlefield, urban trauma care, rural health care, and general surgery. Research is needed that exploits recent advances in micro-electro-mechanical systems to design intelligent, minimally-invasive, medical/surgical delivery systems. The ultimate design will have a surgeon sitting at a telepresence workstation, telerobotically performing complex procedures on a patient, who will be located in a sterile medical van on site. The surgeon will have motor and sensory (visual, tactile, force, auditory) sensations as if she were inside the patient's body. Specific technical areas include distributed, hierarchical control of intelligent micro-mechanical systems, geometric aspects of control design, fault -tolerant and limited bandwidth communication issues, interaction between information and dynamics, non-invasive physiological remote sensors, integrated force and tactile sensing, tele-taction, finer robotic manipulators and instruments specifically configured for surgery, control of telerobotic surgical systems with time delays, telerobotics with sensory enhancements, telepresent and virtual environments for training, man-machine interaction and integration issues.

PHASE I: Research is needed in the areas of distributed, hierarchical control of intelligent micro-mechanical systems, geometric aspects of control design, fault-tolerant and limited bandwidth communication issues, interaction between information and dynamics, non-invasive physiological remote sensors, integrated force and tactile sensing, tele-taction, finer robotic manipulators and instruments specifically configured for surgery, control of telerobotic surgical systems with time delays, telerobotics with sensory enhancements, telepresent and virtual environments for training, and man-machine interaction.

PHASE II: This phase will concentrate on integration issues and the development of prototype telerobotic systems.

POTENTIAL COMMERCIAL MARKET: Hospitals, health care delivery systems, training at medical and nursing schools.

A96-037 TITLE: Design and Synthesis of Novel Nanolaminate Materials

CATEGORY: Basic Research

OBJECTIVE: Provide new approaches for the rational design and manufacture of lightweight radhard, acoustic suppressive or chemically resistive materials from novel nanolaminate materials.

DESCRIPTION: Interactive experiment/first principle calculations, in-situ process control, non-equilibrium processing and interphase control with gradient materials in conjunction with suitable design principles can provide unique structural materials surfaces for Defense Materiel. Refractory metal, boron- carbon-nitrogen hierarchial structures are reasonable targets for neutron, gamma and x-ray resistance. Broad classes of ternary and greater constituent number systems have possible applications and can be non-equilibrium processed with in- situ process controls by evolving ion beam, plasma and laser processing as well as more traditional nanostructural processing technologies. Acoustic suppressive materials involve wider use of interactive design techniques combined with acoustical characterization of nanodimensional multimaterial laminate structures. Experience has shown that nanolaminate materials have significantly different properties with respect to bulk materials such as current active materials (ie. Ti-Ni alloys).

PHASE I: Investigate and demonstrate feasibility of innovative approaches to the manufacture and bonding of diverse materials for specific applications to include lightweight radhard, chemically resistive and acoustic suppressive nanolaminate materials. Establish chemical bonding and structure of new materials with HRTEM, XPS, RAMAN etc.

PHASE II: Provide prototype with design and manufacturing approaches and cost information. Demonstrate improvements through prototype evaluations and tests. Identify possible military and commercial markets.

POTENTIAL COMMERCIAL MARKET: Noise and radiation damage resistance are major environmental hazards in both the commercial and military sectors. The research is intended to provide new innovative approaches to minimizing these in industry, medicine and on the battlefield.

A96-038 TITLE: Hierarchical Polymer Bonded Ceramic Structural Composites

CATEGORY: Basic Research

OBJECTIVE: Mimic nature's design (synthetic Nacre) for ultra-thin-polymer matrix bonded ceramic "brick and mortar" composite and characterize the mechanical properties.

DESCRIPTION: Nature provides many examples of high strength, high toughness inorganic/polymer nano-composite structures in shells, bones, teeth, and horn which incorporate hierarchical design. Ceramics offer many advantages in strength, hardness, elastic modulus, wear resistance, and chemical resistance at ambient as well as elevated temperatures. A thin organic/polymer bonding film between ceramic grains has been shown to increase toughness and strength in nacre. This research should focus on engineering ceramics such as oxides, carbides or nitrides and should address such concepts as the molecular level adhesion, hierarchical assembly, flexibility, graded structures and method of composite synthesis. The composite should ideally contain greater than 90-95% ceramic phase and consider hierarchical design.

PHASE I: Develop strategy for polymer/ceramic design, fabricate and characterize the microstructure of a prototype composite.

PHASE II: Produce components for advanced mechanical property testing and evaluation.

POTENTIAL COMMERCIAL MARKET: If fully successful, this material would have many military and civilian applications for example; a toughened, wear resistant structural ceramic component having superior acoustic damping, fire resistance, ballistic performance and/or abrasion resistance. In addition to the increased performance, economic factors may favor the low temperature processes envisaged in this work.

A96-039 TITLE: Novel Polymeric Membranes for Reverse Osmosis Water Purification

CATEGORY: Basic Research

OBJECTIVE: Develop a new type of polymeric membrane for water purification by reverse osmosis that is more efficient and robust than those currently available commercially.

DESCRIPTION: The U. S. Army has a need for efficient water purification capability in a variety of field settings and uses commercially available reverse osmosis elements in its water purification systems. The capabilities of these systems do not fully meet Army requirements, thus the need for a significant advancement in this technology is evident. Logistics, maintenance time, and cost are all important issues since these systems currently require frequent replacement of ineffective membranes which seriously diminish performance. Poor membrane performance (and even total failure) typically results from fouling and degradation of the membrane due to many factors including bacterial growth, degradation by chlorine, and normal wear. Lengthening the shelf life of replacement membranes is also an important issue since they need to be transported and stored for extended times while exposed to a variety of different environments. This solicitation seeks to solve these problems through the development of a new polymeric membrane for use in reverse osmosis water purification. Approaches could include developing a new membrane formulation based upon new kinds of polymers and combinations of polymers, or improving current membranes through new designs or new methods of preparation and processing. The goal is a membrane that resists fouling, resists degradation due to exposure to contaminants such as chlorine, is physically robust for long- term usage and storage (especially in the dry state), desalinates under standard seawater conditions, and has an improved flow rate. The overall

performance of the membrane must exceed current commercial performance. Environmental cognizance is necessary when choosing materials and processing methods.

PHASE I: Demonstrate proof of concept for a new polymeric membrane for reverse osmosis water purification that is resistant to degradation and fouling with substantially increased efficiency and storage life.

PHASE II: Optimize water purification efficiency and cost effectiveness by fine tuning membrane properties. Demonstrate that membranes can be produced with uniform properties during manufacturing.

POTENTIAL COMMERCIAL MARKET: The new reverse osmosis membrane would significantly lower water purification costs incurred by users by increasing system efficiency while requiring less frequent membrane replacement. With an active and growing commercial market already established for water purification systems, the advances proposed here would be of great value to both vendors and users. The membranes should be developed using environmentally benign materials and processing thus eliminating any negative environmental impact.

A96-040 TITLE: Multi-Body Dynamics and Control for Land Vehicle Simulation

CATEGORY: Basic Research

OBJECTIVE: Develop new modeling and computation techniques, control algorithms, and simulation computer codes for constrained structures consisting of interconnected elastic components that occur in large scale mechanical systems such as tanks, trucks, trailers, etc.

DESCRIPTION: Military vehicles and equipment, such as rotorcraft, tanks, trucks, trailers, and weapon systems consist of complex, interconnected multi-body structures. Traditionally, the dynamic behavior of such structures has been modeled and analyzed on the basis of rigid body models. However, certain components of structures subjected to high intensity dynamic loads undergo elastic deformations that influence ride comfort and the state of stability of the vehicle or structure. To design such structures efficiently and effectively, kinematic and dynamic simulations of flexible multi-body systems based on constrained non-linear dynamics are required. Recent advances in computers and computer graphics hardware and software now permit the development of computer generated animation schemes that facilitate and improve the process of designing complex vehicle structures. For general multi-body analysis requirements, research in computational dynamics, inverse dynamics, augmented Lagrangian methods, etc. for constrained mechanical systems will furnish some of the tools required to develop more robust, numerical efficient, and faster than real time simulators. In particular, automated generation of the equations of motion of complex mechanical systems using icon driven pre-processors is a desired methodology. This process would allow the vehicle modeler (who in general is unfamiliar with computational dynamics theories) the capability to assemble and simulate highly complex systems merely by indicated the types of connective elements between primary structures of the system. It is anticipated that successful completion of the proposed development system would need to incorporate elements of vehicle dynamics formulation methodologies, "X-window" type user interfaces and some degree of internal checking schemes for accurate and realistic modeling. This methodology should also allow for a "turn key" capability that will generate optimized code permitting real time (or near real time) simulation capabilities. This code could additionally be ported to physical motion simulators for use in man-in-the-loop simulation excursions. Also, parameter estimation is a useful methodology for validating simulation models versus actual field data. This could be a part of an expert system that attempts to identify model deficiencies in multi-body dynamic systems. It could also be used for model reference adaptive control schemes, where plant dynamics are not precisely known. Research into structural control methodology within the context of this application is necessary to increase performance of such large complex systems in general and to increase efficiency of the many components in particular. Vehicle rollover, for example, is an important consideration in the design and operation of Army vehicles, and improved dynamic stability controls could be used in a real time sense to help prevent vehicle rollover.

Of special Army relevance is the development of high resolution computer based modeling and simulation methodologies for analytical and physical assessment of ground vehicle systems. Research requirements should be focused on automatic formulation of the constrained equations of motion, symbolic equation processing, parameter estimation, generation of computer codes, computational methods, and algorithm optimization for computer architectures, model reduction and error quantification techniques, fluid payload dynamics, suspension systems and control, weapons positioning control, optimization techniques, and non-linear control methods.

PHASE I: Design and implement X-window and PC windows graphical user interfaces to accommodate multiple simulation methods in support of a virtual prototyping initiative. Emphasis in design should be on the accommodation of several alternative simulation methodologies including recursive, redundant, and symbolic/non-symbolic formulations. Implement a

representative subset of simulation methodologies, including at least one recursive, non-recursive, and symbolic formulation. Design and implement software interfaces to available commercial animation engines, including, for example, Autocad and 3D Studio, for design visualization. Demonstrate feasibility of faster-than-real-time virtual prototyping for military vehicles.

PHASE II: Develop and implement (1) scalable, multi-processing algorithms for dedicated massively parallel processors; (2) scalable, multi-processing algorithms for heterogeneous computing environments; (3) control and design modules for man-in-the-loop evaluation of vehicle performance. Develop automated sensitivity calculations for optimization of control design and of structural response.

POTENTIAL COMMERCIAL MARKET: Improved multi-body dynamics and simulation techniques and robust vehicle control algorithms will lead to better designed structures and systems that will provide better ride comfort, handling qualities, and safety of land vehicles.

A96-041 TITLE: Laser Speckle Interferometry

CATEGORY: Basic Research

OBJECTIVE: Development of a versatile non-invasive reliable tool for the determination of reliability and remaining life of structures under load.

DESCRIPTION: Changes in the sub-microscopic unevenness on the surface of structures caused by anisotropic deformation in the interior can be monitored by and correlated with interference patterns. This technique known as the "Laser Speckle Interferometry" has been developed in the laboratory with Government and Corporate funding over the past few years. In a large variety of structures made of all different kinds of materials, especially under repetitive load, evolution of damage in the interior is extremely difficult to detect and assess. This technique offers a viable approach to the assessment of the effect of evolving damage on the remaining useful life of critical components. Innovative approaches are sought for the purpose of developing a portable field unit for the application of Laser Speckle Interferometry for the health monitoring of critical components of machinery in transportation, manufacturing, construction, farming, and defense related equipment.

PHASE I: Demonstrate the correlation between changes in speckle patterns and type and extent of damage in selected applications-multiple in terms of complexity of geometry, loading conditions and type of material. Concept formulation for a reliable portable unit marketable with respect to cost, maintenance, and use.

PHASE II: Continued product-oriented validation research, prototype fabrication and demonstration. Partnership building, marketing plans, demonstration under widely varying conditions in terms of application, and final engineering.

POTENTIAL COMMERCIAL MARKET: In machinery of different kinds for applications in transportation, construction, agriculture, manufacturing, etc., reliability has often dictated uneconomical downtime and replacement schedules due to excessive safety margins. The availability of a reliable health monitoring technique will eliminate unreasonable logistic burden. The commercial potential is limited only by the imagination of the product developer.

A96-042 TITLE: A Multi-Parameter Snow Sounding Probe

CATEGORY: Basic Research

OBJECTIVE: To develop a multi-purpose probe for the purpose of making direct, in-situ measurements, from the surface, of one or more of the following internal snowpack physical parameters: (1) density, (2) temperature, (3) wetness, (4) grain size, and/or (5) cohesion or strength. This probe should be field portable and capable of storing multiple data sets, each representing an individual sounding made up of several channels. The I/O (Input/Output) interface should be compatible with existing desktop micro-computers. In addition, the device should be capable of displaying the most recent sounding or retrieving a previous one.

DESCRIPTION: The performance targets for the snow probe are as follows: density resolution from 5% through 70% ice matrix by volume, with the water equivalent of the total sounding able to be recovered from the density profile; temperature resolution to 0.5C over a range of -70 to +20C; wetness resolution to c. 0.2% for a range from 0.2 to 10% liquid water by volume; and grain size resolution should be < 1-2mm. Strength and indexes of strength or cohesion are not well defined. However, weak layers in the snowpack that are of interest are often on the order of a few millimeters in thickness, therefore any measure of strength would need to resolve variations at this scale.

PHASE I: Phase I work will concentrate on either of two tasks, depending on whether the initial goal is a single-parameter probe or a multi-parameter probe. In the former case, the Phase I task would be the development of a prototype snowpack probe containing the single parameter measuring capability. Included in this prototype integration should be the necessary sensors, data logging capability, and power supply. This field-portable prototype would be developed and supplied to the Army for field testing at various alpine, winter, and polar sites. In the instance where the objective is a multi-parameter probe capable of measuring at least three of the five desired parameters, the Phase 1 task would be the development of the necessary sub-system technologies associated with each of the selected snowpack properties to be measured by the multi-parameter probe.

PHASE II: For Phase II, the task for the single parameter probe would be the expansion to a multi-parameter capability for the measurement of at least three of the five desired parameters, whereas in the case of the multi-parameter probe, the fully-developed sub-systems would be integrated into a prototype probe. In both cases the fully-developed multi-parameter, field-portable prototype would be supplied to the Army for field testing at various alpine, winter, and polar sites.

POTENTIAL COMMERCIAL MARKET: The commercial market for this technology is high. There is an acute need for the characterization of snowpacks by the military, government agencies, and the civilian winter recreation community. Therefore, a multi-parameter snow probe has significant potential for a worldwide commercial market.

A96-043 TITLE: Reactor for Control of Fugitive Emissions of Toxic Gases

CATEGORY: Basic Research

OBJECTIVE: Development a small-scale reactor for the destruction of toxic gases such as volatile organic compounds (VOC's) and hazardous air pollutants (HAP's). Target gases are toluene, xylene, and methylene chloride. Ideally, this reactor would utilize discharge or beam excitation of the contaminated gases and should have the capability to handle relatively low air flow volumes with toxic gas loading in the 1-1000 parts-per-million range, with a 99% or higher destruction efficiency and minimum formation of toxic by-products.

DESCRIPTION: There is a need to control the fugitive emissions of hazardous vapors resulting from operations at Army plants and depots. Typically there are a substantial number of sources for fugitive emissions during such operations as manufacturing, cleaning, paint stripping, and painting. The emissions may be continuous or episodic and are quite variable in terms of toxic gas loadings, covering a large concentration range from parts-per-million (ppm) to parts-per-thousand (ppt). Optimal technologies for VOC and HAP control currently do not exist that offer a high degree of destruction without significant drawbacks. Both high- and medium -temperature (catalytic) oxidation are quite costly and produce large amounts of global warming gases such as CO2 as well as unwanted combustion by-products and filter techniques have problems of saturation and ultimate disposal.

PHASE I : The Phase I work would concentrate of developing a small reactor capable of successful (299%) destruction of parts-per-million range air flows containing toluene, xylene, and methylene chloride. This laboratory-scale reactor will contain infrared and visible ultraviolet windows for tunable infrared laser absorption and visible ultraviolet laser induced fluorescence diagnostics that will be provided at an Army laboratory.

PHASE II: In Phase II, a scaled-up prototype reactor will be developed and tested. This reactor will need to exhibit the following features: (i) Operating life greater than 500 hours before service, (ii) successful destruction of target molecules to the levels required, (iii) quantitative assessment of any by-products, (iv) development of a means of secondary treatment, should the level of toxic by-product production be below the required level.

POTENTIAL COMMERCIAL MARKET: The commercial market for hazardous fugitive gas emission control technology is substantial, both in U.S. and abroad. As regulatory requirements are slowly tightened, the need for such high-performance cost-effective, and versatile technology will increase.

U.S. Army Aviation Research, Development, and Engineering Center

A96-044 TITLE: Incrementally Adjustable Helicopter Rotor Blade Tracking Tab

CATEGORY: Exploratory Development

OBJECTIVE: Incrementally adjustable, non-metallic tracking tab for helicopter rotor blades.

DESCRIPTION: Tracking tabs are used by most helicopter rotor blades to reduce vibration in forward flight. Current rotor blade tracking tabs are thin aluminum plates located on the blade trailing edges. These tabs are adjusted with a calibrated bending tool to alter the track of individual blades in forward flight, thereby compensating for small manufacturing differences between the individual blades of the rotor. When the track of all blades are nearly identical, the once-per-rev vibration of the rotor is minimized, leading to reduced crew fatigue, increased component life, and reduced maintenance for the helicopter. Advanced rotor systems are designed with non-metallic composite materials for fatigue strength and low observable characteristics. Such rotor systems require non-metallic tab materials, however. This presents difficulties in tracking adjustment, leading to complex and inefficient methods such as heating and cooling the tab material. It is desirable to provide the Army with a non-metallic tracing tab which may be adjusted incrementally without the use of special tools or procedures. An incremental adjustment capability would allow the maintainer to know the magnitude of each adjustment, and would result in the minimum number of adjustments to achieve rotor blade track.

PHASE I: Preliminary design and material evaluation.

PHASE II: Full-scale design, fatigue and environmental testing.

POTENTIAL COMMERCIAL MARKET: Applicable to all commercial as well as military helicopters, at least one per blade.

A96-045 TITLE: Advanced Materials for Helicopter Propulsion Systems

CATEGORY: Exploratory Development

OBJECTIVE: Develop innovative Gas Turbine and Mechanical Power Transmission materials which would greatly increase the power-to-weight ratio, reliability, and fuel efficiency of current and future helicopter propulsion system components.

DESCRIPTION: This topic focuses upon the development of advanced materials for use in the two major areas of the helicopter propulsion system.

The first area of interest is the turboshaft engine. Increases in power-to- weight ratio and reductions in specific fuel consumption of future Army turboshaft engines dictate that rotor speeds and temperatures will increase significantly. Advanced materials which can accommodate these speeds and temperatures and provide high durability and reduced weight are desired. Materials under consideration include Organic Matrix Composites (OMC's) for inlet housings and casings; Titanium based Metal Matrix Composites (MMC's), orthorombic titanium, and super alpha-2 titanium for use in axial and centrifugal compressor rotors; gamma titanium aluminide for use in the compressor diffuser; high temperature materials such as Ceramic Matrix Composites (CMC's) for use in the combustor liner; and a combination of materials with much greater temperature capability such as fourth generation single crystal alloys, intermetallics and in-situ monolithic ceramics for use in the gas generator and power turbine stages. The application of these advanced materials will necessitate more than a material substitution to take full benefit of the materials. For example, concepts involving replacing disks by rings, utilizing a dual microstructure in the disk, or dual alloy components are currently being pursued. Thus, innovative structural concepts, design methodologies, and the strong desire for an affordable manufacturing process should be seriously considered.

The second area of interest is the helicopter main reduction gearbox. The main transmission of all modern rotary wing aircraft is composed of a set of high precision gears and their supporting bearings which reduces the high speed output of the turboshaft engine to that required by the main rotor. In order to maximize the payload of the rotorcraft this system must be as light and compact as possible. Due to the flight critical nature of the transmission system it must also be highly reliable. The U. S. Army is interested in the development of advanced manufacturing techniques which would reduce the friction and heat generation created in the surface contact regions of gears and bearings and allow current design allowables for scoring and pitting to be greatly increased. If successful, this technology could result in a large increase in the load capacity of high performance gears and bearings which would translate into reduced weight, volume, and cost or increased reliability. Possible approaches could

include the use of innovative surface coatings, heat treatments, and surface finishing methods. In addition, the U. S. Army is also interested in the development of innovative techniques for increasing the strength properties of gear teeth and bearing races through the custom orientation of the material grain flow and structure to match that of the part geometry and stress field.

PHASE I: Proposed efforts should define the operational requirements of the application for which the material/material system is to be applied. Effort should be conducted to evaluate the feasibility of the manufacturing process necessary to utilize the proposed material/material system in the selected component. The critical processing steps should be identified and preliminary bench type testing of the critical steps should be conducted. These tests should be sufficient to evaluate the potential of the proposed material/material for further development.

PHASE II: Efforts in Phase II shall be focused upon the fabrication of a full scale component which can be tested in either a current or advanced development gas turbine engine or rotorcraft main reduction gearbox. The proposed effort should address the development of a complete manufacturing process for the subject material/material system.

POTENTIAL COMMERCIAL MARKET: The technologies used in the propulsion systems of helicopters are common to just about all forms of aerospace propulsion systems. This is especially true for turboprop type commuter aircraft which historically have utilized military engines as the basis for the development of new commercial products. The gears and bearings to be developed here will be directly applicable to the propeller gearbox of the commuter aircraft as well as the many other locations where lightweight highly durable gears and bearings are used. Thus the potential commercial market is quite large for the application of the advanced materials which would result from the materials developed from this topic.

A96-046 TITLE: Computer Modelling and Simulation for Helicopter Pilotage Tasks

CATEGORY: Exploratory Development

OBJECTIVE: Develop a methodology to model and simulate a range of flight maneuvers and relate this characterization to the pilot-aircraft response requirements.

DESCRIPTION: Recent research in rotorcraft handling qualities has been fairly good at establishing stability, control response, and coupling requirements for a particular task. This involves using complex ground-based and in-flight simulators to investigate a wide range of controller and stability and control parameters for a specific task; collecting supporting qualitative pilot opinion data using the Cooper-Harper rating scale; and correlating these quantitative and qualitative data to formulate criteria. This iterative and expensive process is valid for the task investigated. If the task changes, the process has to be repeated. The Goal of this SBIR topic is to expand the data base analytically instead of having to investigate every specific mission task element. This will reduce the design-development costs for upgrades to current aircraft and for new aircraft through unifying results and requirements for a variety of tasks/missions.

PHASE I: Requires innovative research in the areas of pilot modeling, rotorcraft inverse modeling, pilot-vehicle-task analysis, and simulation. Sample tasks will be analyzed to develop and characterize the important pilotage -task metrics, pilot workload effects, and vehicle dynamic relations.

PHASE II: Using the sample task characterization, extend the metric to new tasks and validate using ground and in-flight simulation. Extend to all axes of control for day/night and poor weather mission tasks.

POTENTIAL COMMERCIAL MARKET: With the rapid increase in on-board computational power and replacement of current-day control rigging with automatic fly-by-wire control systems, the achievement of tailored flight control laws to improve mission performance, reduce pilot workload, and increase operational capability and safety becomes practical. For example, improving the capability and reducing the workload for Emergency Medical Services missions in poor weather at night would extend operational capability and reduce accidents which will lead to improved life saving capability.

A96-047 TITLE: Human Performance with Decision Aiding Systems: Training for Trust and Measuring the Benefits

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this effort is two-fold: 1. to understand and develop new approaches for any unique requirements that decision aiding systems impose on user training, for example training the user to trust the decision aid

properly; and 2. assuming a properly trained user, to develop methods of effectively measuring human performance benefits of decision aiding systems, specifically situation awareness and workload.

DESCRIPTION: Human interaction with decision aiding systems is fundamentally different than interaction with simple machines. One example is trust: effective use of decision aids demands that the human place some degree of trust in the system. Too little trust renders the aid ineffective and possibly counter-productive; too much trust or misplaced trust can have disastrous consequences. And although the user is taught the mechanics of operating the system, little or no training is given on how to trust the system. Also, we do not have well understood, well defined ways to measure a user's trust in a decision aiding system. Another example is the human system interface (HSI) problem of information transfer. The decision aid must transfer the right information at the right time and in the right manner to be of benefit to the human. A decision aid that effectively transfers information produces the benefits of increased situation awareness and decreased workload. In the past, however, measuring these two benefits has been difficult and disappointing. This effort will explore human performance with decision aids from two aspects: user training to build not only proficiency but also proper trust in the system, and measuring situation awareness and workload.

PHASE I: The first phase will identify any unique requirements that decision aiding systems impose on user training, develop method(s) to satisfy those requirements, develop method(s) to measure user situation awareness and workload, and identify a decision aiding system with which to perform the Phase II effort.

PHASE II: Conduct an operational test of the decision aiding system identified in Phase I to implement and evaluate the developed training and measurement methods. Choose the most promising methods, perfect them, and reevaluate them in a second operational test.

POTENTIAL COMMERCIAL MARKET: Decision aiding systems are currently being developed in the medical and combat aviation arenas, with others likely in air traffic control, nuclear power, other combat systems, emergency response, and mining operations. As more and more decision aiding systems are developed and fielded, these training and measurement methods will become crucial, since decision aiding applications are usually with life-critical systems. They will produce better decision aids and better users, and therefore, safer and more reliable life-critical systems.

A96-048 TITLE: Aerodynamic Analysis of Unsteady Airfoil Geometry in Unsteady Flow

CATEGORY: Exploratory Development

OBJECTIVE: Development and validation of a computer code for the prediction of aerodynamic forces on airfoil geometries that undergo a change in shape while immersed in an unsteady flow environment. The airfoil to be analyzed may have one or more moving surfaces and/or surface transpiration (blowing or suction) with a prescribed schedule. The character of the onset flow can be described as a mean flow with prescribed unsteady pitching and translation (up-down and fore- aft).

DESCRIPTION: Military and civil helicopter development suffers because of the inability to accurately simulate, during design, the complex aerodynamics that affect the forces on the rotor blade. Each element of the rotor blade sees an ever-changing velocity. The forces generated at the rotor blade are dependent on how the airfoil responds to this changing onset flow. The changing distribution of pressures over the airfoil can be determined through analysis using unsteady flow modeling. A rotorcraft development is the application of active controls to modify the geometry of the rotor blade for noise reduction, vibration reduction and correlated with predictive analysis. A key element needed to improve the predictive analysis is the development of an aerodynamic analysis that predicts the unsteady effects of changing airfoil geometry in the unsteady flow environment. This analysis will be based on a coupled viscous/inviscid approach with wake modeling to capture unsteady boundary layer separation.

PHASE I: Investigate current computational methods that are efficient and adaptable to a range of airfoil configurations. Investigate intuitive user interfaces for description of the airfoil geometry and unsteady onset flow. Select an efficient and accurate solution methodology. Demonstrate a test case using the selected methods using 'pilot' coding.

PHASE II: Design and implement a final software solution for computer platforms in current use by army aviation engineers and civilian aerospace users. Develop the software with particular attention to the user interface and desired output products. Use existing standards for airfoil file formats where possible. Select a range of validation cases that demonstrate the accuracy of the final analysis. Document the final software for potential users and for future development.

POTENTIAL COMMERCIAL MARKET: This analysis will provide a benefit to a wide range of unsteady aerodynamics problems. Its use is seen in future aviation systems with as wide a scope as sport sailplanes to commercial transports. Its use is also possible in submarine and sailboat applications.

A96-049 TITLE: Turboshaft Engine and Rotorcraft Drive System Technology

CATEGORY: Exploratory Development

OBJECTIVE: To develop innovative gas turbine engine and mechanical power transmission component technologies which will provide future Army rotorcraft with engines having increased power-to-weight ratios and reduced specific fuel consumption and drive trains that are lightweight, have lower levels of noise generation and have improved durability.

DESCRIPTION: The general path to increasing propulsion system capability includes, but is not limited to, higher maximum temperatures to increase the output per unit airflow; less weight per unit airflow is required to increase the output per unit weight; and increased component efficiencies for decreased specific fuel consumption while maintaining or increasing component durability and life and maintaining or decreasing cost per unit output. To achieve the necessary future propulsion technology advances, technology strides in the compression systems; combustion systems; turbine systems; controls and accessories; and mechanical systems of a gas turbine engine are required. Specific propulsion technology development areas include high pressure ratio, lightweight compressors; combustors that are lightweight with reduced pattern factors and higher inlet and outlet temperatures; lightweight turbines with increased temperature capability, reduced cooling air requirements, and high work extraction; advanced materials/materials systems and innovative structural concepts to accommodate the stresses developed at the required higher speeds and operating temperatures. Thus, future propulsion systems necessitate further developments in aerothermodynamic design capability for improved component efficiency levels and improved control of heat transfer; and further developments in mechanical designs for application of higher temperature, lightweight materials in conjunction with innovative structural concepts to maintain life and durability. These engines produce high speed/low torque shaft power output. Typically, a reduction gearbox or set of gearboxes is used to change the output to the low speed/high torque conditions required by the aircrafts main rotor. Thus, innovative technologies which can reduce the weight, lower the noise, and increase the reliability of these reduction gearboxes are also desired. This could be accomplished with high capacity spur, helical, and bevel gearing, lightweight ballistically tolerant shaft/coupling concepts, overrunning clutches which can operate at engine output speeds, high capacity rolling element bearings, lubrication methods, and the application of advanced materials to components of the drive system. Incorporation of ceramic and hybrid (ceramic rolling elements and metal race) bearings hold potential for decreasing the weight and increasing the life of rotorcraft drive components. However, there is no simple, accurate and cost effective method of detecting deterioration of these bearings. Thus, development of a health monitoring system for ceramic and hybrid bearings would facilitate incorporation of these advanced bearings.

PHASE I: Define a novel concept or innovative technology which is potentially applicable to future turboshaft engines or rotorcraft drive systems. Based on the technology to be pursued, devise a methodology which addresses and substantiates the feasibility of the proposed approach. Define the potential benefits achievable through the application of the proposed concept/technology.

PHASE II: Pursue further the technology defined in the Phase I effort. Fabrication and component or subcomponent testing should be performed to substantiate the technology and its intended end application. The technology should be suitable for transition into a turboshaft engine or rotorcraft drive system.

POTENTIAL COMMERCIAL MARKET: Aircraft gas turbine engine and drive system technology is vital to the US industry base. Gas turbine engine and rotorcraft drive system technology is applicable to both the military and commercial markets. Potential technologies resulting from this effort would provide significant benefit to future rotorcraft and ensure continued US preeminence in the increasingly competitive international marketplace.

A96-050 TITLE: Graphical User Interface for Comprehensive Rotorcraft Analysis Software

CATEGORY: Exploratory Development

OBJECTIVE: Development of an intuitive graphical user interface for finite- element based comprehensive rotorcraft analysis.

DESCRIPTION: Recently developed comprehensive rotorcraft analysis codes permit the rotorcraft industry to perform increasing complex and realistic analyses of rotorcraft phenomena. Unfortunately, these codes are often quite cumbersome to use because of the large quantities of data needed to guide the complex solution algorithms and to define the major structural, aerodynamic, propulsion, drive train, and control system components of the rotorcraft model. A graphical user interface which allows a user to drive the program, rather than be driven by it is needed. The interface paradigm must be internally consistent, must map satisfactorily to the database structures resident in the current program, and be intuitive to an engineer.

PHASE I: Develop an appropriate user interface paradigm and design. Write a demonstration implementation, and demonstrate it on a typical rotorcraft analysis problem.

PHASE II: Implement and deliver code for this user input interface. Deliverables should include code, a completed user manual, and design documentation.

POTENTIAL COMMERCIAL MARKET: Validated comprehensive rotorcraft analysis capability is sorely needed in both military and commercial markets. This software provides finite element comprehensive analysis with a user-friendly, user interface. This capability could be applied to all new commercial designs and product improvements reducing time and design and analysis cost.

A96-051 TITLE: Three-Axis Fiber Optic Gyroscope

CATEGORY: Exploratory Development

OBJECTIVE: The principle objective of this effort is to develop and demonstrate a compact three axis fiber optic gyroscope (FOG) possessing a high degree of accuracy and reliability with low drift characteristics.

DESCRIPTION: Emerging FOG technology has demonstrated that the stringent performance required by current and future navigation and alignment systems can be met. This performance, however, comes at the cost of significant size and weight growth, often causing system packaging problems. A smaller, more compact 3-axis FOG system developed under this effort will substantially reduce FOG packaging problems while enhancing reliability, increased performance, and simplicity, but maintaining low production cost.

PHASE I: Research and laboratory development of a 3-axis fiber optic gyro that is innovative in terms of packaging (size and weight) and performance (low drift, stability over temperature, and reliability). The design must be low cost to manufacture and be universal in application.

PHASE II: Manufacture of six (6) 3-axis FOG packages for testing and evaluation to determine the quality of the manufacturing process which will help determine the overall package cost with quantity as well as the fault rate for manufacture of a 3-axis FOG of this design.

POTENTIAL COMMERCIAL MARKET: Because of their low cost and simplicity, FOGs are becoming more desirable for use in a number of navigation and alignment systems. The increase in performance due to technological breakthroughs is encouraging and has prompted gyro users to look once again at this technology. As this technology is pushed more towards smaller packaging with higher performance, much broader applications will be found for the fiber optic gyro.

A96-052 TITLE: Display of Aircraft State Information for Ambient Vision Processing Using Helmet Mounted Displays

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this study is to demonstrate and determine any advantages of displaying aircraft state information on a helmet mounted display in a manner which will allow the information to be interpreted by the ambient vision processing mechanisms of the brain, as opposed to the focal vision processing mechanisms.

DESCRIPTION: Methods currently exist for providing helmet mounted display information in a form that requires focal vision processing by the brain for interpretation. New methods, however, must be developed for displaying information that can be interpreted with ambient vision processing and are compatible with the unique requirements of helmet mounted displays. These unique requirements include minimizing the masking of imagery and correlating the displayed aircraft state information with the imagery. In addition, some information may need to be in a form that can be processed by both focal and ambient vision

processing mechanisms. Research has shown that ambient vision processing does not require mental attention. The potential advantages of processing aircraft state information using ambient vision mechanisms are reduced pilot mental workload, and a reduced chance of not noticing deviations of aircraft state from the expected state. In addition, research has shown that humans primarily use ambient vision, not focal vision, for attitude and velocity cues while standing, walking or running. Therefore, aircraft state information presented in a manner that can be processed by ambient vision processing mechanisms may be quicker to interpret, with less chance of misinterpretation.

PHASE I: A literature search will be made of the subject area. A report of previous work will be generated. Candidate methods of presenting information will be demonstrated on a workstation monitor.

PHASE II: A method will be developed for presenting aircraft state information on a simulator. The simulator can be low cost workstation. However the simulator must have a rudimentary rotorcraft model driven by a joystick. In addition the simulator must have a helmet mounted display, and head tracker. The simulator must display synthetic imagery of the outside terrain from the pilot's eye point in the model. Aircraft state information must be overlaid on top of the imagery. Aircraft state information must be presented in two ways:

a. Interpretable and optimized for ambient vision processing.

b. Interpretable and optimized for focal vision processing.

The simulator will be flown by U.S. Army pilots. Changes suggested by Army pilots will be implemented and tested. A qualitative and quantitative assessment will be made between the final configurations of the two ways in which information is presented (items a and b above), using experienced Army rotorcraft pilots.

PHASE III: Aircraft state information interpretable and optimized for ambient vision will be displayed on a helmet mounted display on a rotorcraft in flight. Information presented will be world stabilized, requiring a head tracker. The information presented will be correct according to the true state of the aircraft. The aircraft will be flown by U.S. Army pilots. Changes suggested by the Army pilots will be implemented and tested. The final configuration of information optimized and interpretable with ambient vision processing will be qualitatively and quantitatively assessed against information optimized and interpretable for focal vision processing.

POTENTIAL COMMERCIAL MARKET: Providing information in a way that allows ambient vision processing would be useful in all military vehicle crew applications such as rotorcraft, bomber aircraft, tanks, and submarines. These principles would also be useful in law enforcement and medical aircraft. Pilots for underwater remotely piloted vehicles can use this technology (telepresence). Similarly, the principles would be valuable in any virtual reality environment.

A96-053 TITLE: Smart Data Links for Unmanned Aerial Vehicles

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this effort is to develop a low cost smart data link system for Unmanned Aerial Vehicles (UAVs). Innovative applications of low cost communication systems along with the use of AI can result in a system capable of navigation and communicating at low levels. The purpose of this work is to explore the potential impact of a low cost smart data link system for UAVs, and to identify the communication/AI technologies and/or deficiencies. The technical issues that require investigation are communication links, integration and AI.

DESCRIPTION: Current UAV systems are limited by their ability to communicate while navigating at low levels. The ability to communicate at low levels could be done by using mission planning algorithms and digital data of aircraft locations to plan positions that would allow for line of sight communication. The smart data link could store critical data and decide the optimum location to transmit that data back to another aircraft. The effectiveness of UAVs could be increased by removing the requirement of constant line of sight communication. The ability to communicate while navigating through and around obstacles is a complex problem that requires the integration of communication systems, mission planning, and Artificial Intelligence (AI).

PHASE I: The contractor shall define (1) the communication systems to be integrated for the selected approach, (2) the mission planning algorithms that will be used, (3) the level of AI that will be used and how it will accommodate various static and dynamic movements simultaneously. The contractor shall demonstrate the system in a simulation environment.

PHASE II: The contractor shall refine and integrate (1) the communication systems to be used, (2) the mission planning algorithms that will be used, (3) and the AI that will be used. The contractor shall demonstrate the system in a hardware in the loop demonstration. The contractor shall identify the target UAV platform. PHASE III. The contractor shall integrate the system onto a UAV platform. The contractor shall demonstrate the system on the targeted UAV platform.

At the conclusion of each of these phases, a final report shall be presented which summarizes the results of each program phase and documents overall conclusions and recommendations supported by the analysis.

POTENTIAL COMMERCIAL MARKET: New knowledge and technology advances resulting from this development will enable UAVs to communicate without extensive communication and support systems. It will provide a stepping stone for much broader applications to dual use of UAVs in the future. This effort also is critical to battlefield dynamics, and warfighting systems.

A96-054 TITLE: Universal Cargo Net with Release Feature

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this effort is to develop an advanced technology cargo net that will: 1. be made of a more durable material than current nets, 2. attach to a helicopter internal/external cargo (INTEX) pallet, and 3. is capable of being retained by the lifting aircraft after the load is released.

DESCRIPTION: Current 5,000 lb and 10,000 lb cargo nets are made of nylon and require that either the cargo be removed before the lifting aircraft can depart or the net must remain with the cargo when the aircraft departs. Initial concepts for INTEX pallet nets produced a one piece net that was cumbersome and could not release the load on the pallet. A universal cargo net needs to be developed that can: 1. transport general/bulk cargo like current 5,000 and 10,000 lb nets, 2. be made of a more durable material than nylon, 3. be retained by the lifting aircraft after releasing the general/bulk cargo, 4. attach easily to an INTEX pallet, 5. have the strength to be lifted by a helicopter while supporting the INTEX pallet and its load, and 6. be retained by the lifting aircraft, with the INTEX pallet attached, after release of the INTEX pallet load. This effort will result in: 1. longer life nets with commensurate life cycle cost savings, 2. expanded utility of the INTEX pallet system, and 3. quick delivery of supplies for humanitarian and other missions where landing is either not possible or too risky.

PHASE I: Develop the concept and models of a universal cargo net that can release the load it is carrying as described above. Develop a detailed design of the most feasible concept that provides optimum producibility and cost.

PHASE II: Fabricate a prototype system for demonstration purposes. Demonstrate the capabilities of the universal cargo net.

POTENTIAL COMMERCIAL MARKET: Development of such a system would allow commercial helicopter operations to be conducted at lower cost and less risk to personnel. The result would be reduced operation time and improved efficiency of operations for fire-fighting, delivery of humanitarian supplies, logging, and other critical external lift missions. Profitability would be enhanced due to increased utilization and reduced support crew requirements.

U.S. Army Communications and Electronics Command

A96-055 TITLE: Integration of Voice Traffic with Asynchronous Transfer Mode (ATM) Technology

CATEGORY: Engineering Development

OBJECTIVE: Develop a system for the integration of voice traffic directly with synchronous transfer mode (ATM) technology using commercial technologies and products (NDI/COTS) to allow voice phone calls to be made through an ATM system.

DESCRIPTION: The commercial market for ATM currently utilizes systems such as ISDN and PBX to accommodate voice users. These approaches do not take full advantage of the capabilities of ATM. In many military contingency operations, the ability to utilize a portable integrated system consisting of several voice phones, a workstation platform, and an ATM networking system would be beneficial in the dynamic environment. The direct integration of voice capabilities with ATM switching technologies will add functionality, permit bandwidth efficiency, and can be directly interfaced to the ATM data systems at hand.

PHASE I: Feasibility study, research, evaluation, and demonstration of integration of voice circuits directly into an ATM switch interface for voice connectivity to other ATM-enabled voice users as well as common Public Broadcast Exchange (PBX) and Integrated Services Data Network (ISDN) technology users and supporting imagery and data subscribers using multimedia-enabled workstations.

PHASE II: Demonstration of the integrated ATM system for voice over a tactical communications link, such as Tactical Satellite (TACSAT), while allowing connectivity for the public phone systems using PBX and ISDN technology users and supporting imagery and data subscribers using multi-media enabled workstations.

POTENTIAL COMMERCIAL MARKET: NDI/COTS for ATM systems will allow true ATM voice connectivity. Commercial markets Will support this research. The Department of Defense will also support this research, as the DoD efforts in tactical ATM will also benefit from ATM-enabled voice systems.

A96-056 TITLE: Advanced ATR Algorithms for Performance Testing

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this SBIR is to obtain automatic target recognition (ATR) or image processing algorithms that significantly enhance the ability of a human operator to make optimal use of the information available on the modern battlefield and using state-of-the-art sensors.

DESCRIPTION: To date, ATR algorithms have not proved to be robust with respect to the variations in target signatures resulting from field-expedient countermeasures or meteomlogical conditions. As a result, the current view of the ATR is to provide information to the human operator that will provide him with cues and/or other tools that will significantly increase his ability to locate and identify targets. This SBIR seeks to identify algorithms and/or image processing methods that can be applied in real time and that will improve performance of the human operator.

It is assumed that the human operator will have a full set of information available to him. For example, the sensors available could include, but are not limited to, thermal imagers, TV, millimeter wave radar, laser rangefinders, LADAR, acoustic, and seismic devices. In addition, digital map information could be available as could information on the location of self and friendly forces through the transmission of global positioning satellite data. The human operator has a wide variety of information sources at his disposal. The optimal use of this information for effective target acquisition, tracking, identification, and servicing becomes a matter paramount importance.

The task of this SBIR is to provide those algorithms, concepts, tools, or methods that serve this purpose. The algorithm suite could include special modules for detection of moving targets, use of bandwidth compressed data, or the integration of information from several of the on-board sensors. The tools available to the operator could also include selectable edge extraction, local contrast enhancement, zoom, target tracking, model overlays, and other image processing techniques that enhance the ability of the operator to separate targets from background elements or identify vehicle types,

PHASE I: Demonstrate the methods, algorithms, or hardware for improving human operator performance at the NVESD ATR Evaluation Facility. The methods, algorithms, and/or hardware must be fully described at the time of evaluation, including description of the phenomenology being exploited and details of the process. Phase I demonstration shall be done with human operators and should be conducted in near real time. Intermediate results of processing in Phase I may be required for performance assessment and for feedback to the developer for use in optimizing algorithms.

PHASE II: Upon the successful completion of the Phase I effort, a Phase II award may be made. The Phase II effort shall address any and all deficiencies noted in the Phase I demonstration and shall provide the necessary hardware/software for a complete evaluation Of the tools at the NVESD ATR Evaluation Facility. While Phase I may include some notional sources of data input, the Phase II effort requires real data, real information sources, and real time processing. At the time of Phase II evaluation, a description of the algorithm, sufficient for architectural analysis and mapping into open systems architecture will be provided. The use of industry standard busses and chip technology is required. Intermediate results of processing in Phase II will be required for performance assessment and for feedback to the developer for use in optimizing algorithms.

POTENTIAL COMMERCIAL MARKET: The potential commercial market includes use by the transportation industry for the identification of defective materials, aviation warning systems, medical application for the prescreening of radiographs or other pathology reports, and the communications/information transmission industry.

A96-057 TITLE: Novel Template Generation and Neural Network (NN) Applications for Automatic Target Recognition (ATR)

CATEGORY: Exploratory Development

OBJECTIVE: An In-House Laboratory Innovative Research (ILIR) IS currently being conducted to explore novel concepts and their application to the problem of Automatic Target Recognition (ATR) using both Synthetic Aperture Radar (SAR) and Forward Looking Infrared (FLIR) sensors. This effort will generate and test three sets of algorithms: algorithms to create templates for ATR; Neural Network (NN) based algorithms that use signal decomposition techniques to enhance classification performance and reduce training time; NN based algorithms that use data compression concepts to help define a robust set of features. In addition, a bayesian algorithm will be implemented to assess the benefits from integrating the declarations from the FLIR and SAR ATR algorithms. The objective of this effort is to continue into a laboratory demonstration real time demonstration.

DESCRIPTION: This effort involves the use of three concepts:

a. Template generation. This method will take into account additional conditions in template creation process which are aimed at improving the performance of classification algorithms. The approach here aims at maximizing the metric value (using correlation, goodness of fit, etc.) of the target class while minimizing the metric value for the other classes.

b. Pretraining by target signature decomposition. Well documented limitations in NN is the long training time required to get an acceptable solution. In an approach developed using one dimensional signals, the signal is decomposed into a basic set of signals called the basis set. The NN is trained to recognize the signals in the basis set to produce the pretrained network. The pretrained network is than used as the starting point for final training to produce a classifier. The approach not only reduced training time, but also reduced the amount of training data to produce better performing networks.

c. Feature extraction by target signature compression. Some researchers claim that the output of the hidden layer in the NN contains the feature being used by the net to classify the signal. The study of what's hidden in the hidden layer has been difficult because of the complexity of the layer's output. One approach is to train the NN to reproduce the input signal at the output. If successful, the target features for the input are present in the output of the hidden layer since the information is used to reconstruct the input at the output. Compression is given by how much smaller the hidden layer is from the input layer.

PHASE I: a. Algorithm definition study. This study will include an analysis of the ILIR results, a literature search of template generation techniques, pretraining techniques for neural networks and neural network compression concepts. b. Development of algorithms, c. Survey of SAR and FLIR sensors, d. Simulation. Contractor will provide a laboratory demonstration simulating the SAR and FLIR sensors, using real SAR and FLIR data provided by the government. The target set will be limited to seven different classes. Demonstration will show how the three algorithms work in each sensor to identify targets. In addition, demonstration will include the use of a bayesian algorithm to integrate the ID declarations from the SAR and FLIR ATR.

PHASE II: a. Increase the robustness of the algorithms using the results from Phase I. b. Contractor to conduct a real time demonstration using SAR, FLIR sensors and the algorithms developed in Phase I.

POTENTIAL COMMERCIAL MARKET: Medical imaging techniques, commercial aviation industry, intruder detection and identification, manufacturing inspection and intelligent highway system devices are potential commercial applications.

A96-058 TITLE: 3D Visualization of RF Propagation in Terrain

CATEGORY: Exploratory Development

OBJECTIVE: The Army requires innovative techniques to represent, visualize, and reason with ground-based three dimensional models of radio frequency (RF) energy especially as it is attenuated due to terrain blockage, competitive RF, atmospheric absorption, and other sources of interference. The primary application for the visualized RF environment is airborne collection management of very high frequency (VHF) radio energy, although other applications are plentiful. This effort is not concerned with planning the airborne collection management process, but rather in developing a virtual environment of 3D antenna patterns over terrain that will ultimately serve as the front end to a flight path mission planning problem (note: some of the antenna patterns will represent desirable places to fly, whereas others must be avoided, due to electronic interference or physical threat to an aircraft).

DESCRIPTION: Consider the problem of visualizing a system of three dimensional RF antenna patterns dispersed over the surface of the earth. The purpose of modeling and visualizing 3D antenna patterns is to produce a virtual digital environment in which flight path collection management of VHP energy may be explored by a battlefield mission planner (although the planning process is not the purpose of this work). The antenna patterns may be perceived to be models of RF energy propagated from ground-based locations. Some of the patterns are omnidirectional and may be represented with simple hemispheres, but more prevalent are directional antenna patterns with lobed behavior. An antenna's radiation pattern may be derived by analyzing station gain and path loss. Traditionally, antenna radiation has been characterized by appealing to two planar cross sections - the E plane representing a cutting plans of lines of electric force along the axis of the antenna, and the H plane, representing magnetic force perpendicular to the E plane. 3D Visualization requires the cross section concept be extended to depict antenna radiation as a translucent solid. Coordinates of the RF solid will be represented in the Autocad Drawing Exchange Format (DXF) to be compliant with popular modeling, rendering, and animation programs. "Nested" translucence will permit viewing of RF energy buried several levels below that represented by other sources of RF energy. Concepts supporting 3D visualization of RF energy and the flight path planning process are currently being developed at the IEWD as part of the Automated Map based Intelligence Support System (AMBISS), using Sun Sparcstations and a Silicon Graphics Indigo2 workstation.

PHASE I: During Phase I the contractor shall perform development to support 3D RF visualization, focused on the VHF directional antenna problem. Successful bidders will have experience with the Terrain Integrated Rough Earth Model (TIREM), a model designed and validated by the tri-services to represent path loss suffered by pairs of antennas respectively transmitting and receiving RF energy in the VHF portion (30-300 MHZ) of the electromagnetic spectrum. Also, the contractor shall be familiar with RF propagation using gridded databases such as Digital Terrain Elevation Data (DTED) or Digital Elevation Matrix (DEM). Received favorably will be those proposals indicating technical expertise with the emerging field of scientific visualization, including the topics of 3D modeling using DXF-formatted models, texture mapping with translucent, corrosive, bump-mapped and other surfaces, rendering modes including ray tracing, and experience with Silicon Graphics or OpenGL graphics programming. Competence with animation is also a desirable credential (RF energy may be perceived as pulsating when a signal fades or surges; also an RF radiation surface changes dramatically as a transmitter or receiver moves through rugged terrain). Deliverables shall include an interim report, a final report and a limited prototype demonstration of an environment containing a terrain populated by multiple texture-mapped 3D DXF models of directional, lobed VHF antenna radiation.

PHASE II: Phase II will be a full blown implementation of 3D RF visualization, extending the environment from VHF developed in Phase I to other forms of RF, including HF and radar. The contractor will perform the development using Digital Terrain Elevation Data (DTED), Arc Digitized Raster Graphic (ADRG) map products, and RF modeling software approved and validated by the tri-services. The implementation shall be compatible with UNIX- based platforms, with special emphasis on the Sun Sparcstation or Silicon Graphics workstations.

POTENTIAL COMMERCIAL MARKET: Commercial broadcasting networks and aerospace companies may be interested in the demographic impact of the technology as a means of visualizing the extent of propagation of VHF energy over a given geographical area or airspace. Law enforcement and security organizations could leverage the technology for surveillance applications. The earth resource exploitation and surveying industries may be interested in the technology as a means of visualizing communications when exploring new territories.

A96-059 TITLE: Intelligence Preparation of the Information Battle Space

CATEGORY: Exploratory Development

OBJECTIVE: Understanding the information battle space is critical to providing support to both the C2-attack and C2-protect parts of C2W. Intelligence Preparation of the Information Battle Space (IPIBS) will serve as the fundamental building block for all C2W actions. The objective of this project is to develop the capability to overlay leadership decision making profiles onto the technical information processing capabilities of an adversary to determine the probable courses of action of that adversary, and how those courses of action can be influenced by C2 attack.

DESCRIPTION: The adversary decision making template is produced from AI assisted analysis of the leadership/personality profiles of key leaders and their related decision processes, matched against a set of problem types. similarly, a technology/culture based information infrastructure template is constructed from information technology and regional and country intelligence data bases. A C2W situation template is then created by superimposing the decision making process template on the information infrastructure template. Using AI assisted analytical tools, the C2W situation template is analyzed to determine strengths and vulnerabilities. The same process and analytical tools will be used by counter intelligence soldiers to conduct

vulnerability assessments of the friendly information system and provide recommendations for improving Operational Security (OPSEC) and to protect the C2 system. The capability to thoroughly understand and graphically depict the information battle space is the fundamental basis for the successful execution of C2-attack operations. The IPIBS, and the analytical tools used to produce it, then become the wargaming, mission planning and mission rehearsal tools that are used to develop alternate C2W Courses of Action (COAs), predict effects, and conduct mission planning. Building on the intelligence mission of conducting electronic warfare, other sophisticated electronic attack operations will be planned and executed by intelligence units as part of the commander's C2W plan/strategy.

PHASE I: An analysis will be conducted which addresses the decision making processes of the various types of leadership profiles possible and how these decision making processes might be influenced by attacks on the information infrastructure. Phase I will culminate in a report that will describe the approach to implementing the IPIBS.

PHASE II: Phase II will involve development of a prototype system that implements the overlay of leadership profiles onto the information infrastructure and how attacks might be used to cause desirable outcomes. Several scenarios which represent typical war and operation other than war situations will be provided by the government and the system will be exercised against these scenarios. At the end of Phase II a report will be delivered that describes the results of the project. All software developed will be compatible with IBM PCs or equivalent.

POTENTIAL COMMERCIAL MARKET: The tools developed in this project would be useful for analysis of a firm's competitive position in a given market, and how that market might be influenced by actions taken by that firm to improve its position. These tools would also be useful for product marketing analysis and decision making.

A96-060 TITLE: Wideband Fast Switched RF Synthesizer

CATEGORY: Exploratory Development

OBJECTIVE: Develop Fast Tuning Synthesizer(s) which can be used to rapidly tune over the 0.4 to 22 GHz range.

DESCRIPTION: Given the very short on-time of modern emitters at any given frequency, it is necessary for modern Signals Intelligence (SIGINT)/ Electronic Support Measures (ESM)/ Electronic Intelligence(ELINT)/Electronic Attack (EA) systems to rapidly tune to the proper frequency to intercept, identify and counter threat signals. The synthesizer should exhibit tuning speeds of <500 nanoseconds between band edges, the synthesizer must have sufficient frequency accuracy to permit the successful demodulation of narrow band signals to allow the generation of the appropriate countermeasure waveforms. The design will allow use as a coherent signal source, will strive to be inexpensive and lightweight and will use commercial and industrial system/subsystem components where appropriate.

PHASE I: This phase would define the design parameters and component limitations that would reflect the state-of-the-art in synthesizer technology available to meet the stated performance goals. The innovation would be in techniques/ technology which would enable the stated performance to be realized in minimal size, weight, power, and cost. The design and simulated performance of a prototype would be developed.

PHASE II: The proposed prototype would be built, tested, and integrated with the IEWD Electronic Support (ES)/EA Testbed to show its rapid tunability and frequency accuracy.

POTENTIAL COMMERCIAL MARKET: Home Satellite Systems, Commercial TV broadcast, elemental absorption line analysis, Radio astronomy.

A96-061 TITLE: Integrated Low-Cost Ku Band Transmit/Receive Module

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate a single chip, low power, Ku band Transmit/ Receive module

DESCRIPTION: Ground surveillance radars and on-the-move satellite communications antennas need phase arrays to form and point beams. Current work on high power modules does not satisfy the needs stated at a cost effective price. A major component of the coat is the large multi-chip packaging required. Both phase shifted and comparator source generator designs with single and dual paths will be considered with either gating or circulator isolation. Output power of 600 mw per path in desired after an 16-18 dB gain. The receiver side needs 18-20 dB of gain with a PHENT (paeudoheteromorphic high electronic

mobility transistors) or other low noise preamp. All gains need set and dynamic gain control matching. Phase control should be at least five bits and separate for the XMT (transmit) and RCV (receive) paths. On-chip logic will be serial feed and have storage for beam patterns and gains at several frequencies. A $ 100 large quantity packagable design is sought.

PHASE I: Investigate and choose an appropriate target technology. Choose a circuit architecture. Design and develop a board containing all the digital control logic in an available technology. Determine whether a single chip design is feasible or not. Do a computer layout of the logic and RF in the target technology with RF path simulation.

PHASE II: Translate the Phase I design into a mask set for prototyping. Produce enough packaged chips for testing. Make any design adjustments and produce forty operational packages for prototype testing on a candidate phase array.

POTENTIAL COMMERCIAL MARKET: The main market would be for satellite and ground point to point communication antennas from moving platforms. Single chips would be suitable for small area motion detectors.

A96-062 TITLE: Low Light Level Solid State Sensors

CATEGORY: Exploratory Development

OBJECTIVE: Develop shortwave detectors sensitive in the 1 to 2 micron waveband

DESCRIPTION: The focal plane arrays that are sensitive to reflected light in the 1 to 2 micron waveband. This focal plane should operate with minimal cooling (greater than 230K) to achieve image intensifier like performance. The array should also have pixel sizes close to image intensifiers (7.5 microns). A test array shall be built and tested to demonstrate low light level performance.

PHASE I: Develop material sensitive to reflected light in the 1-2 micron waveband. Make a small focal plane array and evaluate.

PHASE II: Develop high performance large format reflected light sensitive 1-2 micron focal plane arrays that has image intensifier like performance. Demonstrate sensor by building a small low light camera.

POTENTIAL COMMERCIAL MARKET: The commercial market would consist of small low light camcorders.

A96-063 TITLE: High Power Tunable Output Filters for Electronic Attack (EA) Systems

CATEGORY: Exploratory Development

OBJECTIVE: Development of electronically tunable output filters for EA transmitters. These filters will replace the use of mechanically or PIN diode switched filter banks. Filters are used in EA to prevent the emission of unwanted frequencies, the increasing bandwidth requirements of modern EA systems call for increasing numbers of filter banks. The filter banks in order to survive the high power used in EA systems tend to be large and heavy. Considerable size and weight savings could be realized by using tunable output filters which would reduce the number of filters needed. Another benefit of tunable filters would be a much faster switching speed, PIN diode switches are currently the state-of-the-art in speed while the mechanical switches are significantly slower.

DESCRIPTION: The tunable filter concept is based in the variable capacitance of semiconductor junctions. It may be possible to develop a power varactor device capable of surviving in the output circuitry of a high power RF amplifier. Another possibility would be to investigate the use of current high power Field Effort Transistor (FETs) and Bi-Polar Junction Transistor (BJTs) as voltage or current controllable variable capacitances which could be used as part of the tunable filter. In both cases models of the devices can be used to develop circuits that can be used to estimate the bandwidth limitations of this approach. The goal of this effort is to design a filter system capable of operating over the HF and VHF frequencies, 1 to 300 MHZ, and handle a power output of 2 kW with as few filters as possible.

PHASE I: This phase will investigate the possible tunable filter topologies and the device parameters needed to achieve the goals. SPICE models shall be used to predict the performance of the filter structures. Semiconductor simulations, ouch as PISCES, shall be used to predict the performance of any specially design discrete devices. Testing of commercial FETs and BJTs to determine their suitability for this application is encouraged. The Final Report for Phase I will indicate the best solution to the high power tunable filter problem.

PHASE II: During this portion of the effort the contractor will be required to fabricate and test a representative filter circuit based on the results of Phase I. All methods and techniques used to fabricate the filter or any single device in this design must be based on standard industry technologies and practices. The contractor shall verify the operation of the filter by providing demonstrations of the final configuration.

POTENTIAL COMMERCIAL MARKET: Potential markets are commercial broadcasting, cellular base stations, broadband test amplifiers and high speed HF Automatic Link Establishment (ALE) systems.

A96-064 TITLE: Non-destructive Real-Time In-Situ Analysis of Vacuum Grown and Processed Infrared Materials and Sensor Arrays

CATEGORY: Advanced Development

OBJECTIVE: Non-destructive real-time in-situ electronic and, chemical analysis of MBE (Molecular Beam Epitaxy) grown and vacuum processed infrared materials and arrays using x-ray and Auger electron spectroscopy.

DESCRIPTION: Develop and install high resolution XPS (X-ray Photoelectron Spectroscopy) and digital scanning Auger with computer controlled sample stage for the non-destructive analysis of three inch diameter wafers. This includes the custom sample exchange, vacuum. Vessel and sample stage which provides for tilt nondestructive chemical profiling, resolution, both energy and spatial, must be sufficient to address II-VI compounds and alloys, particularly HgCdTe, and the resulting sensor array elements. This must be accomplished with source energy densities- low enough not to damage the materials or devices under evaluation. AU analysis, data acquisition reduction, and storage must be fully automated computer operations. An example configuration which addresses time requirements would include an x-ray monochromatic source, significant multichannel detection (minimum of 15) high resolution electron energy analyzer of long focal length (to clear wafer during tilt) and high resolution and sensitivity scanning Auger with low beam currents. Example specification would include signal-to-noise for Auger greater than 800:I (1000:I preferred) greater than 500,000 counts per second above background at 1OkV at 10na, and for XPS a source resolution of 0.5 eV or less and an analyzer resolution of 25mv with a resulting count rate near (within 10%) 500,000 counts per second at 0.6eV resolution,

PHASE I: Design and install vacuum vessel and automated 3 inch diameter wafer stage to demonstrate wafer transfer and manipulation with existing Auger single Plus Cylindrical Mirror Analyzer (CMA) analyzer. Design must include all necessary ports and configurations for the proper subsequent placement of energy analyzer, monochromatic x-ray source and Auger electron gun.

PHASE II: Install and integrate all required analysis subsystems and computer work-station operation. Perform those modifications required to incorporate each subsystem into the custom in-situ analysis system These subsystems include: the high resolution electron energy analyzer, the monochromatic x-ray source, the digital high resolution scanning Auger, sample rotation high resolution ion depth profile system, and all required supporting hardware and control electronics. The workstation corner control system required will include all hardware and put software for system set-up, control and data acquisition, data reduction and display, Auger image processing and display, computer utilities, and automatic analysis (to include species identification, atomic concentration chemical state identification, and learned sequence operation).

POTENTIAL COMMERCIAL MARKET: Provides in-situ-high resolution electron spectroscopy for the molecular beams epitaxy, MBE, semiconductor growth community. Currently, the existing options include inadequate add-on components or external small sample systems which expose samples to ambient conditions. This addresses the need for rapid high quality non-destructive in-situ analysis in large wafer production growth systems.

A96-065 TITLE: Integrated Detection and Location of Buried Metallic and Non-Metallic Targets

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate the feasibility to detect and locate shallow buried landmines.

DESCRIPTION: The objective is to develop and demonstrate a detection technologies capable of detecting and locating shallow buried landmines. These mines are metallic and nonmetallic and they range in size from 3 to 15 inches in diameter. The technology platform can be handheld, vehicle mounted, or airborne. The technical challenge is to develop a system which

distinguishes targets from natural clutter in hardware and/or software. The advanced developed technology shall undergo testing against buried targets in a real, outdoor environment. All phenomenology is acceptable; the following suggestions are suggestions only and are not desired to limit acceptable concepts.

Specifically, hardware research topics might include optimal antenna configuration studies; in-situ soil parameter technologies; broadband, small footprint antenna configuration; x-ray source design using laser technology; infrared sensor with thermal resolution of 0.001 delta T; etc. Software research topics might include 2-D or 3-D imaging technologies independent of type of sensor input; methods of sensor fusion such as neural networks or correlation function: automatic target recognition algorithms applied to sensors, etc. The objective is to also obtain an understanding of the complexity of the detection problem. Mine detection has a long and rich history of technologies which have been pursued and found conclusively to be non-responsive to the mine detection problem. A literature search in previous mine detection technologies previous to the writing of the proposal is desired.

PHASE I: This phase shall include thorough analyses that theoretically and/or experimentally demonstrate the scientific soundness of the phenomenology to detect and locate the objects of interest.

PHASE II: This phase emphasizes field experiments and demonstrations designed to clearly establish the feasibility of the system to detect buried objects in real environmental conditions. The proposal shall accommodate the participation of the system in government blind field testing.

PHASE III: This phase shall emphasize an integrated system with sensor and signal processing onto a mobile platform. This phase shall further emphasize field testing and demonstrations of the system against real targets in real operating scenarios.

POTENTIAL COMMERCIAL MARKET: Mine detection technologies have applicability to various other applications including road inspection, utility line and pipe detection, buried waste detection and non-destructive testing.

A96-066 TITLE: Software Architecture, Tools, and Modules for Soldier Education and Training

CATEGORY: Advanced Development

OBJECTIVE: To develop an underlying architecture, tools, and modules that will enable the development of standardized Intelligent Tutoring Systems (ITS) that will dramatically improve education and training for soldiers, leaders, and public school students.

DESCRIPTION: Computer-based education and training systems, often called Intelligent Tutoring Systems (ITS), have proven their capability to provide these advances. While much work is being done in this area, most applications are stand-alone courseware systems. For the potential of this technology to be fully realized, an underlying software architecture will need to be developed and then adopted as a common standard. A variety of innovative tools and modules will also need to be developed. The architecture will need to be open, modular, evolutionary, hardware-independent, and adopted as a commercial (not just military) standard. Courseware will be developed by many vendors, but will all need to conform to the standard architecture. This will permit students to build a personal student model of their achievement, rate and style of learning, and other factors. It will also permit students to custom design and integrate a complete curriculum to meet their needs, interests, and learning style. Additionally, it will permit a standard approach for measuring the effectiveness of courseware and educational techniques, which will provide a common framework for educational research in this area. Some tools and modules may include: courseware authoring tools, student evaluation modules, courseware-effectiveness evaluation modules, data collection and analysis tools, student model-building tools, or curriculum integration or planning tools.

PHASE I: The contractor will join with others in this field to work toward the development and adoption of a standard architecture. One or more tools or modules will be identified and proposed for Phase II development.

PHASE II: The contractor will continue to work with others in this field to evolve and standardize on an architecture. One or more tools or modules will be developed as proposed. The contractor will work with an Army sponsor to conduct a substantial test of the developed system.

POTENTIAL COMMERCIAL MARKET: Public education is also in need of an underlying software architecture, tools, and modules. The contractor will specifically be working toward the creation of a commercial architecture that will serve both public education as well as military education and training. The tools and modules developed under this contract should have both commercial and military market potential. Additionally, given these things, the commercial market for courseware should flourish.

A96-067 TITLE: High Performance Miniature Antennas for Hand-Held Personal Communication Systems (PCS)

CATEGORY: Advanced Development

OBJECTIVE: RF systems for the Electronic Battlefield will require optimized and equipment specific antennas. Ideally, antenna designs should be specifically tailored to each application and optimized to assure maximum efficiency and gain coupled with minimal physical size and cost. A technology shortfall currently exists in the area of miniature and covert antennas that will be required for battlefield RF terminals to be effectively deployed in support of personal communications services to the soldier. Miniaturized antennas of the future will be required to support a multitude of "Iridium/ Orbcomm-like" low earth orbit hand hold (and smaller) satellite terminals, as well as RF cellmobile soldier terminals operating at VHF and UHF frequencies and ultimately to migrate up to the 20-Ghz (IFF (Identify Friend or Foe)) frequency band.

DESCRIPTION: The intent of this topic is to solicit workable concepts that will result in dual use (commercial/military) high performance, covert, low cost, adaptable (in gain, coverage, and equipment applicability) antennas for hand held use. Such antennas will address the requirement for moderate RF bandwidths and will be optimized for covertness and small physical size coupled with high gain performance. Potential concepts should address the RF and physical operation of the antenna under difficult (environmentally) and widely varying conditions of terrain and environment. Ideally, the proposed miniature antenna concepts will possess the attributes of hemispherical coverage and novel mounting schemes (such as flush mounting, enclosure sharing, etc.), support of frequency agile systems, support of a variety of modulation schemes and introduce technologies at or beyond the state-of-the-art. Narrow beam coverage as an option for use in some specific systems would be a desirable (built-in) enhancement.

PHASE I: Identify advanced concepts and technologies which will offer the potential of covert, high performance antennas stressing: miniature physical size, covertness, high efficiency, low cost, wide beamwidth, reconfigurable for narrow(er) beamwidth, and physical and electrical adaptability to a wide range of existing and emerging RF hand held terminals. Identify several prime candidates for development in a Phase II program. Low technical risk and high potential for successful development and dual use application would be the (technology/concept) selection criteria.

PHASE II: Fabricate, test, and optimize several candidate antennas in to operate in conjunction with an assortment of hand held RF terminal and cell mobile phone handsets. Establish performance criteria and verify through simulation and or live tradeoff analysis to determine and benchmark the antenna that most closely matches the Army's Electronic Battlefield needs for hand hold antennas.

POTENTIAL COMMERCIAL MARKET: Pursue commercial marketing to adapt the antenna to commercial systems such as wireless PCS, Pagers, RF Tracking and tagging systems, Call Mobile telephony, and mobile SATCOM world wide communication systems.

A96-068 TITLE: Intelligent Display of Laser Radar, FLIR and Visible TV Imagery

CATEGORY: Advanced Development

OBJECTIVE: Provide a means of augmenting the ability of tactical users to identify combat vehicle targets by the intelligent display of co-registered data from Second Generation FLIR sensors, Laser Radar target profiles and Visible spectrum TV imagery. Co-registered imagery should be displayed on a monochrome or color monitor such that the means of display augments the operator's ability to discern the internal features of the target beyond that which would be discernible by viewing imagery from a single source.

DESCRIPTION: FLIR imagery at tactical ranges typically presents target imagery to an observer with approximately 25 vertical by 50 horizontal image samples across the target. Laser radar (LIDAR) devices are capable of collecting approximately 10 vertical and 20 horizontal range samples across the target. In some cases, the LIDAR image samples can match the FLIR image samples in quantity one for one. LIDAR can provide range resolution of approximately 20 cm. Visible TV imagery can be constructed such that it provides a one for one map of TV samples in the same quantities as FLIR imagery. In each case while the FLIR, LIDAR and TV image targets are co-registered, i.e., the three target images can be made to coincide spatially, the individual samples may not coregister. That is to say that row n of FLIR samples may not be in the same place across the target as row n of the LIDAR samples. Several attempts have been made to fuse FLIR and TV imagery and several approaches have been attempted to present three dimensional LIDAR images on a two dimensional display, (notably assigning a color to each range bin). To date these have not provided observers with much assistance in identifying targets.

PHASE I: Simulation and modeling using two targets. The contractor shall be provides with synthetic FLIR imagery and TV imagery of two tactical targets, a Soviet T-72 and a US MIA1. In addition, the contractor shall be provided with sufficient dimensional data to construct a LIDAR range map of the two targets. Target data provided to the contractor will be of significantly higher resolution than required by the problem presented in the description, above. The contractor shall model the data using the contractors proposed technique for image display and present the fused data in video tape and digital video formats in 6 target aspects for each of the two targets. Sample to sample registration between FLIR, LIDAR and TV imagery shall be selected randomly. The video imagery shall be presented for each target in each aspect in at least 20 different random sample registration sequences for a total of 240 images.

PHASE II: Demonstration hardware. The contractor shall design develop and deliver hardware and software to fuse the images generated by a Second Generation HTI FLIR, day TV video and a LIDAR profiler. Output of the LIDAR profiler shall be azimuth, elevation and range data for each LIDAR sample. The contractor shall provide the source code of the software, the fusing preprocessor for each band FLIR, TV and LIDAR, the fusing processor and the display. The hardware and software must operate at 30 Hz minimum.

POTENTIAL COMMERCIAL MARKET: This project has commercial applicability for remote sensing devices in Police, Fire and hazardous environment activities where human operators must remotely operate equipment guided by multispectral sensors.

A96-069 TITLE: Double-Sided High Temperature Superconductor(HTSC), Coated Single Substrate (thin-film), for Electronic/ Microwave components & Devices

CATEGORY: Exploratory Development

OBJECTIVE: To deposit HTSC thin-film on both surfaces of a single substrate. Fabricate variety of devices on both sides of the dual-faced HTSC substrates.

DESCRIPTION: Crystalline substrates are used for fabrication of HTSC devices or components. Decreasing the packaging size, increasing the efficiency, and the complexity of devices need be improved to expand the HTSC applications. The goal of this SBIR topic is to explore HTSC thin-film crystal growth on both sides of a single substrate. Furthermore, the resulting films will be used in device fabrication, characterization, and analysis. HTSC devices have shown suitable characteristics in applications such as antennas, and microwave devices. The performance of HTSC components, and their miniaturized dimensions can be greatly improved by utilizing a dual-faced HTSC Targeted application area to demonstrate such improvements are (reduced size, performance & device complexity) In high frequency(HF) antennas, and weight reduction for electronic sensing system for UAV payload applications.

PHASE I: The HTSC material must possess a transition temperature of greater than 80 degrees Kelvin (e.g.,TlBa2Ca3Cu4Oll or YBa2Cu3O7). For successful completion of PHASE-I, three to five different user specified operating devices will be fabricated, tested, characterized, and forwarded to the Army for further evaluation/testing. The government will specify configurations, and dimensions (in the range of 100-200 microns line width) of the devices. In addition to the devices, a formal written report including data, necessary graphs, data analysis, and etc., shall be delivered as part of this contract effort. The formal report must include, but not be limited to, the following salient technical areas: a detailed description of dual-faced thin-film deposition technique/ process; a detailed description of in-situ(preferably), or post annealing process; informative data on dielectric properties of different suitable substrate materials, and the particular substrate chosen for this project; detailed description of patterning procedure; a detailed comparison between the proposed method and those already existing in commercial HTSC fabrication industries; a detailed DC & AC test data and characterization of the devices (RF maximum frequency of 2 Ghz); recommendations on future devices and applications.

PHASE II: Phase II is the further investigation of the previous phase, and fabrication of more complicated devices (multi-port configurations, sensors, and antennas). Twenty devices will be fabricated, tested, characterized, modified if necessary, and delivered. A formal report, similar in scope to the report submitted in Phase I, is required.

POTENTIAL COMMERCIAL MARKET: The above technological effort can be implemented in variety of commercial applications related to integrated & microelectronics, civilian space technology, microwave, satellite communications, and etc.

A96-070 TITLE: Soldier Situation Awareness and Well-Being

CATEGORY: Exploratory Development

OBJECTIVE: This exploratory development will research several conceptual opportunities to restore the diminished audio cues to the soldier in the described hostile environment. The effort will result in the demonstration of a combination of innovative technologies that enhance soldier awareness in a "cacoon" situation and permit him to perform the mission functions despite the threat of directed subliminal acoustic emissions. These functions will include the normal Command, Control and Communications required for tactical: situation assessment (enemy and friendly), planning, execution, status reporting, location reporting, synchronized action, reconnaissance, and physical well- being.

DESCRIPTION: Soldier performance in a modern battlefield environment is becoming increasingly demanding on the human sensory facilities and more lethal due to threat of biological, chemical, and other agents. Adding to the threat are electro-optic, electromechanical, and explosive weapons design to inhibit human performance by blinding, deafening, and transmitting subliminal commands disrupting normal cues. The logical defense mechanism to these threats has been to encapsulate and try to isolate the soldier from the hostile environment. When the human head is enveloped in a protective sealed helmet or the soldier confined to a sealed vehicle; he becomes disoriented because of the denial or mismatch of ordinary sensor cues. Compounding this problem is the need for the soldier to maintain communications on one or more nets which require wearing an earphone(s). The resultant effect causes the soldier to lose the vital situational awareness and well-being needed to react to changing threats and to carry out his mission.

PHASE I: Conceptually define and design a special audio transducer array to accurately capture the dynamic sound pressure waves. Develop the optimum geometry and time delay architecture to differentiate and resolve the directionality of the source. Formulate fast analog to digital converter and digital sound processing designs suitable for the processing of transducer array data into time and frequency domain coefficients. Use the signal processing capability to regenerate the captured sound pattern and format the data for presentation to the human listener such that audio cues seem natural and permit sound source direction, identity, and tracking capability using an encapsulating helmet or in a confined space. Provide a technical report on the findings and demonstrate the feasibility of approach.

PHASE II: Conceptualize and demonstrate audio cue enhancements so as to "focus" on a selected and background noise diminishment. Using the combination of sensor array and digital signal processor pin-point sound sources and amplify the sound simulating more sensitivity than the normal human ear. Develop and demonstrate integrated audio appliance prototypes that can accommodate the soldier communication and sound actuated systems in a "hands busy" environment. Integrate the regenerated environmental and spatially referenced audio cues on the same audio appliances. Prepare a Phase II plan for the development and demonstration of a fieldable audio cue restoral system that would optimize the lower echelon command, control, and communications needed to enhance situation awareness and soldier well-being on a hostile and contaminated battlefield.

POTENTIAL COMMERCIAL MARKET: Immediate applications on surveillance, drug interdiction, hearing protection, human audio sensor enhancement from tactical battlefield to foreign mission assignments. Use of the acoustic control and audio cue restoral will be of benefit in high noise factory production situations and when workers must wear encapsulating clothing such as in asbestos removal, environmental clean-up, nuclear biological active areas, micro-chip production clean rooms, riot control, and fire fighting.

A96-071 TITLE: Moving Target Indicator (MTI) Radar Target Tracking using Context Constraints Derived from High Resolution SAR Imagery

CATEGORY: Basic Research

OBJECTIVE: Use Synthetic Aperture Radar (SAR) imagery to support real time validation of MTI target track association algorithms.

DESCRIPTION: Algorithms for tracking individual ground-based targets in a high target density environment using airborne MTI data tends to be problematic and can benefit from consideration of relevant domain constraints such as vehicle type, terrain obstacles and road networks. Since there exists limited regions of the world where adequate terrain elevation and natural and cultural feature databases exists, the development of context-sensitive target tracking models for ground-based targets tends to be inherently problematic. By using modern SAR imagery, it may be possible to identify certain easily recognizable domain

features that are relevant to the MTI tracking problem. Although the analysis of high resolution SAR imagery for the purpose of extracting relevant domain features pushes the state of the art in image processing, it should be relatively straightforward to develop target association algorithms that produce track extensions that appear to be consistent with these discernible features. Similarly, such algorithms should suppress track extensions that appear to violate discernible domain constraints. For instance, target tracks that correlate with extended lineal objects in SAR imagery may be identified as a road- following vehicle. On the other hand, tracks that correlate with regions of the SAR image that appear to violate mobility requirements for ground-based tracked or wheeled vehicles, such as crossing a lake or ravine, would be suppressed.

PHASE I: In Phase I, algorithms should be developed that demonstrate the effective use of SAR imagery to support target track assignment algorithms for a subset of easily recognizable natural and cultural features. In order for this effort to be successful, fully registered SAR and MTI datasets must be obtained. The use of data from the Joint STARS may be adequate; however, even higher resolution images than generated by JSTARS may be needed to provide adequate detail for the successful fusion of the output from these two sensors.

PHASE II: In Phase II, the number of SAR features used by the tracking algorithm should be extended. Problems uncovered during Phase I should be addressed and resolved. For example, since parts of the road networks may be shadowed in the SAR imagery, the road will appear to be discontinuous. The tracking algorithm should be extended to accommodate at least a few of the typical anomalies observed in SAR imagery. In addition, more comprehensive test and evaluation of the algorithms should be carried out, to include the use of additional SAR and MTI datasets.

POTENTIAL COMMERCIAL MARKET: While available Digital Terrain Elevation Data (DTED) and Data Feature Analysis Data (DFAD) datasets remain limited, many DoD and non-DoD applications exist that require "context-sensitive" evaluation of real time sensor data. Treaty validation and earth resource monitoring, for example, both require the evaluation of real time sensor information with respect to relatively stable domain knowledge.

A96-072 TITLE: Cost Effective Micro-Cell Communications and Situational Awareness using Spread Spectrum and Global Positioning System (GPS)

CATEGORY: Advanced Development

OBJECTIVE: Achieve the functions of Personal Communications Systems (PCS) type communications, position location, and commander's situational awareness of position locations in a cost- effective way by not implementing a separate GPS receiver at every handset location. Added benefits are that each handset is a light as possible.

DESCRIPTION: Present theory of situational awareness calls for embedding GPS receivers in various communications devices and communicating the GPS position data received over a communications link to some data collection center. This topic proposes to develop a system that achieves the same objectives of small cell situational awareness and communications without the added cost, weight, and power (battery) requirements that separate GPS receivers at all user sites would entail. Code Division Multiple Access (CDMA) spread spectrum (developed originally for SATCOM applications) has the benefits of being a multiple-access, low noise, bandwidth efficient modulation technique, but it also has the feature that distance between a transmitter and receiver can be calculated very accurately by measuring the number of Pseudo Noise (PN) chips in the modulation code that have elapsed between transmit and receive time. It is feasible that this technique can be used to provide a relatively accurate position location of handsets within the cell and provide this information to a data collection site and/or back to each user. A potential architecture might be one where a single micro-cellular basedstation is connected to three separate antenna's that receive CDMA spread spectrum communications signals from many user handsets. Three separate antennas must each be known in position and placed far enough apart to resolve the location of all of the transmitting user handsets. Using a differential GPS receiver for the three separate antennas would accomplish this and allow the whole system to be transported periodically to accommodate moving users. Each handset would broadcast their PN codes and be received at slightly different times by each of the separate basestation antennas. Triangulation of these received signals could then be used to determine location of the transmitting signal within the micro-cells coverage area. In this way, only a small number of GPS receivers potentially just one) are required rather than including one embedded with each cellular handset. The system could be used to transmit calculated position back to a user requesting this data if they need to locate themselves on a local map.

PHASE I: Architecture definition, location algorithm development, modeled and measured data to confirm feasibility, and prototype design.

PHASE II: Refined architecture, prototype demonstration, and field demonstration.

POTENTIAL COMMERCIAL MARKET: Related applications are numerous. For example, the systems could be used as a combined paging, locating, and communications micro-call within an office building. Systems like this could be deployed at ski slopes or similar environments where communications and position location are important provided it can be done in a small handset. For instance, users of the system on a ski-slope could then talk to each other (other family members, staff) and be easily found if trouble occurs. The system could be adapted for use on a golf course for determining accurate measurements of distance from the handset to each hole. As commercial applications for such a system expand, costs and availability for DoD uses will decrease.

A96-073 TITLE: Automatic Target Recognition (ATR) for Infrared Hyperspectral Imaging Technology

CATEGORY: Engineering Development

OBJECTIVE: Specific objectives are to expand the applications of second generation thermal imaging technology (Horizontal Technical Integration) to imaging applications that require spectral information. Two principle applications are target identification and chemical vapor imaging. Target Identification - Identification of targets by unique spectral properties has become of increasing interest to reduce probability of false detection or detection of targets in high clutter conditions. This program seeks to develop the capability to image at selectable or tunable spectral bands to increase the imaging contrast available for target identification. Chemical Imaging - The nature of a chemical plume makes it nearly impossible to acquire or track confidently without an image of the (chemical plume) target. Program concept is to provide an enhanced thermal camera that will permit the targeting of chemical plumes and other trace gases from ground locations. This research will provide a novel multispectral narrow band camera that will provide a unique view of the chemicals on the battlefield.

DESCRIPTION: The basic concept is to design a camera that spectrally dithers a tunable filter to permit signal optimization and background rejection. Research objectives involve the application of B-12 um focal planes, tunable filter technology and system development. Principle detector candidates include staring or scanning HgCdTe IRFPAs.

PHASE I: Develop rapid and adaptable spectral modulation techniques between 7.5 and 11.5 um at 0.05 um resolution (5 cm-1 at 10 um) for enhanced suppression of background clutter, detector nonuniformities and other interferences, agent discrimination and detection of additional targets such as troop emissions, ground vehicles, ships, aircraft, projectiles and missiles. Model, design or build optical assembly for use in chemical vapor imaging studies. Identify technical issues (cold filter, detector specifications), redesign and incorporate performance optimization requirements. (3-5 micron chemical imaging systems will also be considered but given less priority).

PHASE II: The goal is to demonstrate a proof of principle brassboard that will permit the imaging of chemical effluents or use spectral identification methods for target detection.
Specific tasks include: sensor performance modeling, compare performance predictions w/performance goals, identify low risk approach, develop test strategy, fabricate and test brassboard generic hardware to integrate tunable filter, customize software for specific applications, laboratory tests, field test for scenarios and final report describing performance for different applications.

POTENTIAL COMMERCIAL MARKET: Societal impact includes improved public health and safety, a means for cost effective environmental hazards reduction and regulation compliance and the enhancement of national security.

A96-074 TITLE: Battlefield Image and Text Distribution Using a Personal Communications System (PCS)

CATEGORY: Advanced Development

OBJECTIVE: There are several sources of video images which can be received by a Common Ground Station (CGS) type earth station. They can be from a satellite, UAV, Tomahawk missile, or a helicopter at the receiving CGS terminal. These images have overlays of coordinates, radar Bites, targets and enemy movements added. No equipment currently exists that is capable of wide area distribution of this information for use by the soldier. The data and image could potentially be distributed over the local area by an inexpensive personal communications type terminal. A relatively high speed PCS can display the local area with troop and vehicle movements. Updating movements and position of enemy troops and equipment can be a matter of minutes. This data can be distributed to field commanders over the battle area in a secure manner.

PHASE I: Survey and study existing PCS concepts which can be used for a local data, digital video distribution system. The system to be a rugged manportable terminal capable of 10 to 15 mile secure communications. For security, the PCS can

be an encoded or spread spectrum type terminal. The terminal should be capable of image updating in 3 to 4 minutes. A flat panel display should be approximately 511x411 in size 50 CGS terminal changes can be viewed. The system to be capable of display/report over multiple interfaces. This terminal should be able to transmit and receive in a cellular mode for a global type communications.

PHASE II: Design or implement an advanced development system to demonstrate the capability of local distribution of secure CGS type battlefield transmission to hand-held data image terminals.

POTENTIAL COMMERCIAL MARKET: Pursue commercial marketing to make technology available to industries for monitoring rapidly changing events over a wireless system.

A96-075 TITLE: Visual Software Development for Parallel Machines

CATEGORY: Exploratory Development

OBJECTIVE: Determine methods and appropriate automated support that will facilitate visual programming for software applications, in particular mission critical, that will be implemented using massively parallel machines.

DESCRIPTION: The SBIR will address the issues associated with providing visual design methods, and associated automated support, for software applications intended for massively parallel processors. Issues include: a process for dividing complex problems into pieces that can be worked in parallel; communications approaches; how to assure a reasonable processing to communications ratio; distributed vs. parallel implementation differences; and application language considerations. To be usable and effective, these methods must follow good software engineering principles, include visual design representation that is integral to the method and support high order software languages, such as Ada 95, and platform independence.

Software is an essential (often the essential) component of most military and commercial systems. These systems involve large volumes of data from a variety of input sources that must be quickly processed and provided to a large number of outputs. This significantly increases the processing capability needed to provide the performance required from these Systems. Distributed computing may provide the more cost effective today, but as the cost and size of the parallel machines decreases, their use becomes more attractive. Creating software that takes advantage of this processing capability requires a software development approach that can decompose the solution into a large number of pieces that can be efficiently performed in parallel. This is not a simple task, since the approach must assure a high processing to communications ratio for the overall application. While it may not be feasible to completely design an application that can run in parallel, distributed, and single processor environments, it should be possible to minimize the effort needed to move from one environment to another. Implementation in High Order Languages, such as Ada 95, which provide support for parallel and distributed programs should help mitigate difficulties encountered, including platform portability. Visual design methods offer a means for improving communications among the design/management team, and assisting developers and maintainers in "seeing" the complexity of the software program.

PHASE I: Select or formulate a visual design method and associated techniques needed for the creation of software applications running on parallel machines, and define automated support required. Additional consideration will be given for proposals that use Ada 95 as the application implementation language and identify potential users, military and commercial, of the proposed product.

PHASE II: Develop a prototype implementation that incorporates and demonstrates the approach and support proposed in Phase I.

POTENTIAL COMMERCIAL MARKET: Commercial corporations in areas such as banking, communications, and oil and natural gas exploration/refinement use large complex software programs in their day-to-day operations. Others, such as retail sales and service organizations, are migrating toward similar situations. Well engineered, understandable, and reliable software running on parallel machines would significantly enhance their operations, and an automated, engineering based visual design method will make that software more available, supportable, and affordable.

A96-076 TITLE: Statistical Overlay of Communications Systems

CATEGORY: Engineering Development

OBJECTIVE: In the Distributed Interactive Simulation (DIS) environment, there does not currently exist the ability to model communications equipment tied to battlefield entities or units, for DIS exercises. This type of representation on the electronic battlefield is required in the Intelligence and Electronic Warfare community to describe tactical situations accurately. There exists in the IEW community, systems that exploit information gained through the interception of communication traffic such as GUARDRAIL and Rivet Joint. Therefore, an accurate portrayal of potential target system is necessary in determining the performance of these collection systems under a variety of battlefield scenarios. The ability of such systems to perform missions in a DIS exercise environment is considered a highly desirable goal since the intercept collection systems are expensive high value assets to deploy.

DESCRIPTION: The proposed effort will develop and model the distribution of communications equipment associated with specified deployed battlefield entities and organizational units in a simulated environment. Further, the deployed Semi -Automated Forces (SAFOR) will produce simulated communications traffic for a variety of tactical battlefield situations. The resulting communications simulation and modeling products will be integrated into an existing, off-the-shelf, tactical battlefield simulation system with Distributed Interactive Simulation (DIS) compliant protocol. Preliminary investigation into target systems has identified synthetic tactical battlefield generators such as Modeled Semi- Automatic Forces (MODSAF) or Interactive Tactical Environmental Management System (ITEMS) as candidate systems that are available and possess the features required.

PHASE I: An initial investigation in determining the organizational makeup of forces that can be represented as Semi-Automated Forces (SAFOR), distributed on the battlefield and the communications devices deployed with these forces will be performed. From this initial analysis, a single communications system will be selected. An implementation approach will be defined that accurately describes the parameters of the selected system will be constructed. Typical parameters would include power, frequency, bandwidth, beam characteristics and other relevant characteristics. The approach will also describe the techniques that will be used to tethered or attached to an entity that has a representation or known model in the DIS environment. The first phase will provide a detailed approach to meet the end goals of this project.

PHASE II: The objective of Phase II is to implement the approach defined in the first phase. software models for communication Systems will be developed and will be tethered to entities on the battlefield. Initially it is envisioned that the definition and deployment of communications devices and associating these devices to entities would be a manual, operator interactive process. The model will be exercised through various DIS scenarios, data will be collected on the performance of a communication collection system. The performance of multiple scenarios will generate a range of data sets that can be used for system sensitivity analysis. Once the basic approach is modeled and is operationally sound an automated deployment system for larger forces in the many on many mods of tactical battlefield operation will be developed. On the simulated battlefield numerous forces must be deployed with a wide range of equipment associated with each entity in a short period of time. It is proposed that an Expert Systems and/or several AI techniques can be utilized in defining these deployment patterns, strategies and equipment distributions on the synthetic battlefield. Some of the areas where expert systems and AI techniques can be applied are listed below. Use of templates or expert systems software in defining the deployed entity or unit. Tactical situation deployment of forces based on preset rules. Varying deployment patterns based on tactical situations or opponent type. In determining the organizational makeup of the Semi- Automated Forces (SAFOR) distributed on the battlefield, several factors comprising the characteristics of specific entities or units on the battlefield with associated communication capabilities require investigation. Some of these factors are as follows: The size of the aggregate unit deployed in a given location. The location on the battlefield of the unit. The type of mission by the unit deployed. The type and experience of the unit deployed. Types of communication equipment available to the deployed unit. C3 methodologies employed by the unit and opponents. Finally, as part of the Phase II effort, development and integration in the following areas will be accomplished. Creation of a communications systems database for entities and units. Integration of a communications database subset (a small number) to a DIS compliant software generation system. The target generation system is TBD (possible candidate systems MODSAF or ITEMS).

POTENTIAL COMMERCIAL MARKET: The Statical Overlay of Communication Systems will be designed around the implementation of tactical communication structures into the DIS environment. The product could be ported into existing simulator designed to analysis link budgets as a method to create a realistic environment or noise to effect link performance. Depending on the AI method used the noise could be a learned from collected test data thus significantly reducing time to develop a scenario. Also depending on the AI method used, that algorithm could be ported to consumer products that require analysis of their environment to determine there operation (e.g. an air conditioner could learn the daily cooling pattern and in the future implement them independently).

A96-077 TITLE: Remoteware for Split-Based Operations

CATEGORY: Exploratory Development

OBJECTIVE: To develop and perform experiments and demonstrations with a standard software mechanism for remotely working with and assisting warfighter(s) in the field. This is to be accomplished by exploring software operating systems and application programs that can be used by two or more people in different locations.

DESCRIPTION: Just as workers can be more productive when assisted by persons performing administrative or other offline tasks, warfighter's can benefit from assistance. The existence of internet services on the Army's telecommunications system can make this possible by providing the infrastructure for these services to be performed remotely, removing the assisting personnel from danger and without them incurring the enormous support costs of fielded soldiers. This task seeks to develop and experiment with facilities which will support this type of interaction between personnel remote from the warfighter location and the warfighter.

PHASE I: The Contractor shall develop a system concept which will provide the technical basis for remote assistance of warfighters and develop initial experience with a prototype applications of this technology.

PHASE II: The Contractor shall develop the technical basis into a standard mechanism to support cross platform remote warfighter assistance applications and develop a number of prototype systems/applications, providing validation of, and experience with, the concept of remote warfighter assistance.

POTENTIAL COMMERCIAL MARKET: This technology can provide the basis for a global market, providing access to personnel in remote, and presumably less costly areas, that can provide services in a more cost effective way than acquiring them locally.

A96-078 TITLE: Large (Virtual) Screen Head Mounted Display for Battlefield Visualization

CATEGORY: Advanced Development

OBJECTIVE: To develop and perform experiments and demonstrations with a virtual, 360 degree, heads-up display mechanism.

DESCRIPTION: The existence of devices for tracking parts of the body, such as accelerometers and eye tracking devices makes possible virtual 360 degree, full color, 3-D display devices, which when combined with 3-D aural devices can provide a virtual experience of virtual and real world objects for training, simulation, manipulation, or computer applications requiring large virtual screens. The user would move his head or eyes to naturally move around the large virtual display. This effort shall design, construct and experiment with a prototype virtual visual/aural display environment, and provide a development environment for developing experimental applications.

PHASE I: The Contractor shall develop a system concept for the display environment and develop initial outline of some prototype applications of this technology.

PHASE II: The Contractor shall develop the system concept for the display environment into a virtual 360 degree, full color, 3-D display device, combined with a 3-D aural device providing a virtual experience of virtual and real world objects and develop a number of prototype Systems/applications.

POTENTIAL COMMERCIAL MARKET: This technology can provide the basis for developing a strong US industrial presence in the virtual reality industry which is currently in its infancy.

A96-079 TITLE: Amplified Optical Splitters for Optically Controlled Phased Array Antennas

CATEGORY: Exploratory Development

OBJECTIVE: The objective is to investigate the development of amplified optical splatters (lossless splatters) for use in optically controlled phased array antenna systems. This will require demonstration of monolithic optical splatters (preferably based upon multimode waveguides, not y-branches) with integral semiconductoroptical amplifiers (SOA). The devices are required to split and amplify orthogonal polarizations equally. Crosstalk between orthogonal polarizations shall be minimized. Techniques to minimize amplified spontaneous emission (ASE) will be addressed. The devices will be used to distribute orthogonal polarized

optical signals to the beamforming photonic integrated circuits. The devices will operate at nominal wavelengths of 1319 nm and/or 1530 nm. The near term goal is to use optical hybrid integration to integrate these devices with optical beamformers. The ultimate goal is to monolithically integrate these optical elements in a single device. This would provide a lightweight, low cost, robust, technically superior optical system for the optical control of phased array antennas.

DESCRIPTION: CECOM, is developing technology leading to the demonstration of optically controlled phased array communications sub-systems for Army communications on-the-move (OTM). Carriers frequencies might vary from 6 to 60 Ghz with data rates of 2.4 Kb/s to 155 Mb/s or more. Adaptive multiple antenna beams and adaptive null capabilities will ultimately be required. Major emphasis is being placed on a high degree of photonic integration to develop modular, scaleable and "frequency independent" subsystems for multiple applications and to reduce size, weight and cost, thus leading to a practical realization for Army tactical systems. Near term emphasis is on optical phase control. The system supports the Army initiative to "digitize the battlefield".

PHASE I: In Phase I, modeling will be conducted to experimentally verify the feasibility of the objective. Initial discrete 1X4 splatters and SOA's will also be developed.

PHASE II: In Phase II, the model(s) will be refined and lX4 and lX16 monolithic amplified optical splatters will be developed.

POTENTIAL COMMERCIAL MARKET: This concept will have potential uses in long haul communications systems, satellite and cable television (CATV) applications. Applications include SATCOM OTM (on-the-move ground terminals) and terrestrial communications OTM.

A96-080 TITLE: Information Display for Battle Damage Assessment (BDA)

CATEGORY: Exploratory Development

OBJECTIVE: Define/develop a user modifiable set of display symbology for Battle Damage Assessment (BDA). The goal is to determine a set of symbol representations which form the building blocks for the unit resource information to be displayed. In addition, an interface is to be developed so that the user can easily design display combinations based on personal preference, and for the declutter of map displays.

DESCRIPTION: Battle Damage Assessment (BDA) is the timely and accurate estimate of damage resulting from the application of military force, either lethal or non-lethal, against an objective or target. One method of keeping the commander Informed of the threat's dynamically changing military capabilities is by displaying the threat's resource information on a map. Display requirements include the capability to annotate the reported resources of a given battle unit and, once a conflict begins, their changing unit strength and effectiveness. Various methods of display are necessary to accommodate user preference and for the declutter of map displays in a dense environment. Viewing the threat resource information allows the commander to make decisions based on the current estimate of the enemy's remaining military capabilities and potential.

PHASE I: Study the current methods of displaying unit resources for BDA. Develop a core set of symbol representations. Design various display methods for core symbol combinations. Design an interface for the utilization and/or modification of the displays and symbols according to user preference and for the declutter of BDA information.

PHASE II: Implement and demonstrate a prototype of the Phase I design. Integrate the Phase II prototype with IEWD designated systems.

POTENTIAL COMMERCIAL MARKET: This technology would be applicable to software display systems for which the information requirements could vary with different users or change dynamically. Areas such as these Include transportation, logistics and weather systems.

A96-081 TITLE: 3-D FPA Process, Operation and Performance Model

CATEGORY: Advanced Development

OBJECTIVE: Extend existing heterojunction device physics model to a 3-D FPA process and device simulation model with the ability to simulate operation of SWIR-VLWIR scanning and staring focal plane arrays. The model will find application at both

ARL and NVESD in groups that evaluate IR detector material and analyze FPA operation and performance. The model should also find application in IR FPA manufacturing and future system simulators that include IRFPA sensors.

DESCRIPTION: The 3-D model shall encompass two areas. IR detector processing and IR sensor operation. The model shall include modules that simulate double layer heterojunction IR detector processes with the output being displays of detector formation, material characteristics and detector performance and modules that simulate scanning and staring SWIR-VLWIR Focal Plane Arrays with the output being FPA performance. FPA performance should be displayed in a 3-D graphics format. The model should also include the ability to flowdown detector performance and material quality from FPA performance input.

PHASE I: Phase I efforts will include identifying existing heterojunction detector models for extension, identifying critical heterojunction fabrication steps and processes, development of models to represent the processes, identifying additional models necessary to fully simulate the operation and performance of IR detectors and FPAs in the SWIR-VLWIR (1-20um) region.

PHASE II: During Phase II software shall be written, fully tested and documented to simulate heterojunction detector processing and simulate and display in a 3-D format IR detector operation and FPA operation and performance. 3-D displays for FPA's shall reveal FPA crosstalk and non-uniformity. The software shall output FPA performance based on material quality and processing parameters input by the user. The software should also be capable of working in the reverse mod so that an output of material and processing parameters can be generated form FPA performance parameters input by the user or passed to the module by the detector processing simulation module. The model shall be validated with data provided by NVESD, in IRIS proceedings and in IRFPA, IR Detector and IR material reports on file at DTIC (Defense Technical Information Center).

POTENTIAL COMMERCIAL MARKET: Commercial processing/manufacture of infrared detectors.

U.S. Army Edgewood Research, Development, and Engineering Center

A96-082 TITLE: Miniature MALDI-TOF Mass Spectrometer

CATEGORY: Exploratory Development

OBJECTIVE: To develop a rapid, sensitive, bioselective technique that provides both triggering (i.e., biosentinel) information and data as to the identity of a biological agent.

DESCRIPTION: Current triggering mechanisms for biological detectors rely on non-specific counting and sizing of airborne particles. Since these methods provide no information on the nature of these particles, false alarms are prevalent. Mass spectrometry is the most sensitive and selective of laboratory techniques for identification of biological and chemical species. Unfortunately, these instruments suffer from size, weight, power supply, fragility and operator requirements which limit their use in the field. Matrix-assisted laser desorption ionization (MALDI) is one of two next-generation mass spectrometric technologies capable of providing considerably enhanced detection and identification of the full range of biological agents (i.e., toxins, bacteria, viruses). MALDI utilizes a very rapid laser pulse of low intensity to vaporize and ionize high molecular weight biomolecules in a matrix of organic material. The process provides a means of mass analyzing fragile large biomolecules with minimal fragmentation as well as minimal multiple charging of the resultant ions. Due to the pulsed nature of the ionization process, MALDI is best suited for coupling with a time-of-flight (TOF) mass spectrometer. The advantages of a TOF mass spectrometer include very high ion transmission (hence sensitivity) and unlimited mass range. Conventional MALDI also requires human intervention to prepare samples for introduction to the mass spectrometer, since MALDI currently requires drying of a liquid sample solution on a substrate. Direct on-line coupling with liquid sample processing techniques as will be required for field analysis of biological agents is not currently facile.

PHASE I: This effort will provide enhancement of MALDI-MS technology through development of improved mass resolution in a compact device and through development of liquid sample introduction approaches permitting direct coupling with analyze chemical separation methodologies for bacterial and viral challenges. Resolution enhancement will be realized through space-velocity correlation focusing.

PHASE II: The full range of factors affecting MALDI=TOF-MS resolution will be defined and the space-velocity correlation focusing method further developed to provide optimum resolution over the widest possible mass range in the smallest possible TOF-MS configuration. The other major instrumental enhancement to be accomplished is to construct and incorporate within the ion source region of TOF-MS a new sample introduction methodology. This new approach utilizes ultra low volume

flow of solvent containing analyze and matrix through a capillary terminating in the ion source region, thus permitting direct on-line coupling of liquid based analyze separation methods.

POTENTIAL COMMERCIAL MARKET: The MALDI mass spectrometric technique is one of two approaches currently very widely used in the biological analysis field (pharmaceuticals development, infectious and hereditary disease studies, etc). The proposed developments will diminish the overall size of the mass spectrometer by a factor of two to three and streamline laboratory applications, thus providing a huge competitive advantage over current approaches. Successful development of the approach will have an impact on the market measured in the tens of millions of dollars. In addition to commercial applications, law enforcement agencies have demonstrated considerable interest in techniques which could shorten the time for DNA analyses. The enhanced resolution and streamlined analysis by the proposed approach in the analysis of DNA fragments will provide an attractive complement in the analysis of such materials.

A96-083 TITLE: High Performance Aerosol Collectors

CATEGORY: Basic Research

OBJECTIVE: To develop a low energy aerosol collector which collects in the sub-micron range while preserving the viability/integrity of the biological agents being collected.

DESCRIPTION: Biological warfare threat agents are inherently aerosols, small particles carried in the air along with the multitude of ambient aerosol particles. Downwind from a release, the concentration falls to very low numbers, and requirements documents specify detection at concentrations of a few particles per liter of air. By comparison, it is not unusual for ordinary air to be carrying a million ambient aerosol particles per liter. Current detection systems (e.g., NDI-BIDS and P3I-BIDS components) require samples on the order of 10,000 particles for analysis which, in order to make a detection quickly, requires a high volume aerosol collector (1,000 liter/min) which concentrates the aerosol into a small volume of liquid. The BIDS system uses multi-stage virtual impactors to accomplish this. While they represent the state-of-the-art, they have several shortcomings: (1) They need a lower particle cutoff of about 1 micrometer in diameter. There is concern that currently required collection time is too long, (2) Virtual impactors are heavy, bulky,, and power consuming, (3) Modifying them to reduce the lower cutoff sizes requires much more power (e. g., cutting the size in half takes about a 4-fold power increase), and (4) Current impactors are such energetic devices, they damage biological particles, which interferes with subsequent analyses that depend on viability. The most important aerosol-concentrating step in these aerosol collectors is the phase change to liquid. Current research offers alternatives to the virtual impactor, and improvements in collection medium which can enhance survivability of injured microorganisms. Furthermore, aerosol inlets do not have the same collection efficiency for all size particles, and these size effects depend on the wind speed and direction. There is a need to develop collectors for employment in much higher winds, but for which the directionality is far less variable. Examples include aircraft carriers operating into the wind for flight operations, aircraft, UAVs.

PHASE I: The focus will be on evaluating the potential for designing a concentrator with a 1 micron cut-off without increasing power utilization. Approaches to design a "bio friendly" collector which reduces physical stress on the biological materials, and collects them in a hospitable liquid for suspending hydrophobic particles and protecting viability, will be stressed. The device shall concentrate at least 350 l/min of air into a small volume of liquid (approximately 5 ml) with 30 percent collection efficiency for 1 micrometer diameter particles using not more than 40 watts.

PHASE II: A low energy, compact, energy efficient, wetted cyclone for UAV scale applications will be designed. Additional new concepts include passive (turbulent) collection to wetted walls in a tipped, sharp edged inlet; low resistance electrostatically charged filters; tortuous path wet walled flow-through tubes; and studies of highly superisokinetic and subisokinetic designs, including blunt inlets for wind direction insensitivity over reasonably forward directions.

POTENTIAL COMMERCIAL MARKET: Applications in the commercial sector include any situation in which air quality must be stringently monitored, such as the manufacture of integrated circuits, hospital surgical suites and isolation wards, or in civil defense applications. The indoor air quality community comprises a number of companies engaged in fulltime such work for industrial and health services clients. They desperately need such a device which could run unattended on battery power overnight. As an indication of the size of this customer base, there are over 15,000 certified Industrial Hygienists in the United States. A significant proportion of them would have a use for such aerosol collectors

U.S. Army Missile Command

A96-084 TITLE: Optoelectronic Packaging for Through-Substrate Communications

CATEGORY: Exploratory Development

OBJECTIVE: To develop materials, devices, and packaging techniques that allow high-speed communications vertically through the substrates of multichip modules (MCMs).

DESCRIPTION: Recent developments in integrated optics technology have led to the capability of hybridizing different material systems onto a silicon chip. This enables the placement of advanced optoelectronic devices onto the chip substrate. Since silicon is transparent to infrared energy, the possibility exists to optically communicate through a silicon substrate using 1.3um sources and detectors. If the chips are mounted to a rigid or flexible MCM substrate that is also transparent to IR, the modules can be stacked three-dimensionally to provide optical communication vertically and electrical communication horizontally and at the module edges. What is needed is a low cost method of packaging these optoelectronic multichip modules to allow for high speed processing within the modules and high speed communications between stacked modules.

PHASE I: Examine material combinations and processes for high density packaging of optoelectronic modules. Determine applicability of available substrate materials. Investigate applicability of off-the-shelf silicon CMOS processors. Perform trade studies on emitter and detector components (LEDs vs. vertical cavity surface emitting lasers, P-i-N vs. metal-semiconductor-metal detectors) and interface circuits. Address design issues relative to alignment of emitters and detectors. Develop basic packaging design for a simple two module, four chip stacked signal processor. Simulate performance and thermal-mechanical characteristics of the processor. Develop engineering estimates for volume manufacturing of the processor.

PHASE II: Design and fabricate a prototype 3D stacked, optically interconnected simple signal processor. Test processor performance and thermal characteristics. Examine cost drivers in fabrication process and recommend cost reduction enhancements. Design and execute a small fabrication run of a Fast Fourier Transform (FFT) processor in a multiple module package.

POTENTIAL COMMERCIAL MARKET: The equipment developed under this SBIR effort would be an enabling technology for the availability of high performance processors for military applications in automatic target recognition, C4I, and digital battlefield applications. Computation-intensive commercial applications include medical sensor data processing, high-end workstations, and supercomputer applications.

A96-085 TITLE: Advanced Three-Phase Combustion Analysis

CATEGORY: Exploratory Development

OBJECTIVE: Develop methodology to simulate combustion of a three-phase fuel mixture in a combustion chamber and determine mixing and combustion efficiency.

DESCRIPTION: Advances in Computational Fluid Dynamics (CFD) for missile exhaust plumes has recently led to vastly improved models for analysis of the combustion of two-phase fuel mixtures in the U.S./Japan Ducted Rocket (DRE) Program. This methodology can be expanded to three-phase fuel mixtures with a reasonable risk.

Recent advances in CFD methodology combined with advances in parallel computing and flow visualization methods have led to the ability to use advanced computational methods to analyze mixing and chemically reacting two-phase flows in three dimensions. This technology advance has led to the design of more efficient inlets, diffusers, and combustors for ducted rocket powered missiles.

The advances have occurred in the use of a Lagrangian formulation for the solid particulates in the flow, an advanced turbulence model using large eddy simulations to determine sub-grid turbulence, and the use of computationally efficient variational techniques in the computational algorithms. These improvements have provided a detailed understanding of the nature of the mixing and combustion never before seen in the technology.

Similar advances can be made for three-phase flow systems by adding liquid thermodynamics to the existing two-phase mixing and reacting fluid dynamics. This element will be added to a time dependent Navier-Stokes algorithm that produces time accurate solutions to the coupled set of partial differential equations.

PHASE I: Technical approaches will be formulated for the addition of liquid phase thermodynamics to existing two-phase mixing and reacting fluid dynamics models to provide an advanced three phase reacting flow computational fluid dynamics model. The formulations will include sub-models to treat each of the flow phenomena such as particle breakup, particle coalescence, phase-change, and liquid/solid phase combustion. At least one innovative sub-model will be coded and implemented to assess the capability and potential for technical advancement. In addition, the enhanced computational fluid dynamics model will be exercised for one proof-of-concept test case to be provided by the Government, a simulation of the combustion of a solid fueled ducted rocket with two phase flow to include both gas and solid phase combustion. The results of this simulation, the predicted combustion efficiency for this engine, will be delivered to the Government for comparison with a measured efficiency. The intermediate results are expected to provide a time space map of the following: a. Gas density b. Gas temperature c. Gas velocity d. Gaseous species mole fractions e. Pressure f. Unburned fuel in the engine g. Temperature of each size of particulate h. Velocity of each size of particulate i. Species composition of each size of particulate j. Turbulent kinetic energy k. Turbulence scale length l. Vorticity

PHASE II: The three phase flow model enhancement formulated in Phase I will be finalized, documented, coded, and incorporated into an existing Government two phase reacting Navier-Stokes computational fluid dynamics model. Additional test cases will be provided by the Government for comparison with measured data to demonstrate the ability of the advanced three phase gas-liquid-solid particulate flow model to solve realistic problems.

POTENTIAL COMMERCIAL MARKET: This is clearly a dual use technology with application to turbine engines (aircraft, helicopters, aircraft auxiliary power units), internal combustion engines (gasoline, diesel) and solid fueled engines (ramjets, rockets, missiles). The commercial market is the aircraft and automotive industries.

A96-086 TITLE: Optical Based Pressure Measurements for Aerodynamic Flows

CATEGORY: Exploratory Development

OBJECTIVE: Development and demonstration of a non-intrusive technique to measure surface pressures on a body immersed in an aerodynamic flowfield.

DESCRIPTION: The rapid advancement of Computational Fluid Dynamics (CFD) has led to a dramatic improvement in the capability to predict flow fields around a tactical missile, a UAV, or a helicopter. These rapid advances are providing the capability to design Army hardware faster and much more accurately than was possible in the past. This predictive tool is, however, limited by the understanding of the physical principles involved in these flow fields. These physical principles must be determined by using both CFD and making experimental measurements in order to understand the physics of the flows. This critical area has also seen improvements recently with the development of new measurement techniques for the flow field. Optical diagnostic techniques have been developed and have been implemented in ground test facilities for the measurement of various flow field variables of interest. Included among these is velocity using Laser-Doppler velocimetry, species density using Raman spectroscopy and Laser Induced Fluorescence (LIF) techniques, as well as temperature using Raman spectroscopy and other laser based spectroscopic techniques. Optically based pressure measurements concepts have been developed but have been applied only in limited situations primarily for research. The state- of-the-art in this technology field is the use of pressure sensitive paints to determine surface pressures on models used in ground test facilities. Only a minimum of technology development in this area is required to allow this technique to attain a wide usage in development projects rather than strictly used in research projects. Optical pressure measurements would provide a complete description of the mean flow field without altering the very flow field that is being measured using conventional pressure transducers by adding pressure to the flow field variables that can already be measured optically and are mentioned above. These measurements would provide a great enhancement in the flow field description by providing blanket coverage of the surface pressure as opposed to pressures only at selected locations where a probe is placed. This allows a visualization of the "forest" without the necessity of extrapolating the forest by looking at a few of the "trees" in that forest.

PHASE I: Work in this phase would be concentrated on producing a feasibility study for the optical based pressure measurement system and the demonstration of a limited capability system. Work would be aimed at choosing specific chemical compounds that will fluoresce at the flow conditions of interest for the ground testing of tactical missiles, UAVs, and helicopters. This choice would involve the combination of high intensity signals for the range of pressures expected for the flow conditions

mentioned, the temperature sensitivity of the active chemical compounds over the same range of interest, and the choice of the laser, the sensor array, the data recording and storage facility, and the software necessary to tie the facility together.

PHASE II: Work in this phase would include the development, design, and fabrication of the system and a demonstration of its capabilities in a ground test facility. Specific requirements include the calibration of the optical measurement system by determining the operating characteristics of the pressure sensitive paint used in the system. These also include a calibration of the pressure maps under various operating temperatures that the paint will be subject to in the ground test facility. Additionally, there is the requirement to provide the software to correct the data for skewed surfaces relative to the optical axis. It will be necessary to develop calibration techniques to provide for both static and dynamic signals from the surfaces of the model to produce calibrated pressures on the model. Methods of addressing the non-uniformity of the paint coating must be addressed. Contamination and degradation of the paint in the wind tunnel environment must also be addressed. This system must be capable of accurate measurement of pressures over a range of operating conditions consistent with the environment seen by Army tactical missiles, UAVs, and helicopters.

POTENTIAL COMMERCIAL MARKET: This is clearly a dual use technology with application to turbine engines (aircraft, helicopters, aircraft auxiliary power units), internal combustion engines (gasoline, diesel) and solid fueled engines (ramjets, rockets, missiles). The commercial market is the aircraft and automotive industries.

U.S. Army Natick Research, Development, and Engineering Center

A96-087 TITLE: Body Heating System

CATEGORY: Exploratory Development

OBJECTIVE: To research, design, and develop a personal heating system to provide auxiliary heat to the individual soldier.

DESCRIPTION: The US Army operates in all climate extremes, including the extreme cold. In extremely cold environments, soldiers wear bulky, insulative clothing. A method to eliminate some of the bulk in the clothing or to extend the mission is to provide auxiliary heating to the body. Currently no lightweight, easy-to-use heating system is available to the individual soldier. Such a system would augment current cold weather clothing ensembles by providing longer durations at colder temperatures or enhance freedom of movement by reducing insulative layers of clothing. The complete system, including power, shall weigh no more than 8 lbs, last a minimum of 4 hours before recharging/refueling/etc., recharging/ refueling shall be accomplished in the field by the individual soldier without tools, shall provide a maximum of 500 watts of heating, shall have automatic control, and shall have minimal signature.

PHASE I: Investigate the various technologies available to provide auxiliary personal heating and identify those that show high potential in meeting the stated objectives. A demonstration of feasibility is highly desirable.

PHASE II: Design and develop a working prototype of one or more of the technologies identified in Phase I. Also demonstrate the effectiveness of the system(s) against the performance criteria.

POTENTIAL COMMERCIAL MARKET: The potential commercial market for such a body heating system is very large. Virtually anyone outside in the cold for extended periods of time would benefit from the system. Such people include: construction workers and linesmen, cold storage workers, skiers, snowmobiles, ice fishermen, scientists, etc.

A96-088 TITLE: Extruded, Shelf-Stable, Intermediate-Moisture Meat Jerky Analogs

CATEGORY: Basic Research

OBJECTIVE: To identify physical/chemical mechanisms responsible for textural changes in extruded meat jerky analog products during storage and to recommend processing/formulation technologies to minimize these deteriorative reactions.

DESCRIPTION: Extruded meat-in-carbohydrate-matrix, intermediate-moisture products are under development as eat-out-of-hand ration components. These products are designed to have flavor and texture comparable to commercially available meat-jerky items, but also to provide carbohydrates as an energy source. Current development has yielded ration prototypes containing approximately a 1:3 meat:starch ratio with a moisture content of approximately 20%. These products are highly

acceptable shortly after extrusion, but toughen significantly after short periods of storage (i.e., a 10-fold increase in elastic modulus after 4 weeks accelerated [125 F] storage).

PHASE I: Produce extrudates having a range of formulations and using a range of process/shear parameters. Also, test different types and levels of plasticizers and humectants. Evaluate textural stability during storage using mechanical testing, and conduct thermal-analysis/nuclear magnetic resonance-evaluation to assess changes in component state (i.e., migration or mobility of water).

PHASE II: Determine mechanism of extrudate toughening. Recommend process/ formulation parameters to minimize textural deterioration.

POTENTIAL COMMERCIAL MARKET: Snack items, high energy (performance enhancing) foods, backpack/camping products.

A96-089 TITLE: Air Release Valve for Airbags

CATEGORY: Exploratory Development

OBJECTIVE: To design, fabricate, and test an air release valve for airbags for soft landing of airdropped payloads.

DESCRIPTION: In an effort to achieve rapid deployment and quick mobility, the U.S. Army is currently investigating using pressurized airbags to absorb ground impact energy and to soft land airdropped payloads. The airbags are made of heavy-duty coated fabric attached to the underside of a platform. The payload is rigidly rigged to the top of the platform. For low G-force soft landing of the payload, the airbag is pressurized first before ground impact. Upon ground impact, the high-pressure air inside the airbag has to be released at a prescribed pressure level to achieve soft landing of the payload. The prescribed pressure level depends on the payload weight, its descent velocity, airbag size, and air release area. Typically, the release air pressure level is about 5 psig and the required air release area is 1 to 2 sq. ft. A simple, low-cost, reliable air release valve is needed for this application.

PHASE I: Currently, the U.S. Army is experimenting with a 8'X4'X2' (height) airbag supporting a 1000 lb. payload. An air release valve operating in the range of 3 to 7 psig with a 1 to 2 sq. ft. release area is needed for this airbag system. In Phase I, a design concept of the air release valve will first be formulated. A prototype of the valve will then be manufactured. The prototype will be tested for its reliability and performance in a controlled environment with air pressure ranging from 3 to 7 psig.

PHASE II: Upon successful performance demonstration in Phase I, the air release valve will be modified and redesigned to be installed on the platform of the airbag system. The entire system will be vertical-drop tested from a crane to evaluate the dynamic performance of the air release valve. The valve design will be further improved based on the test results. At the end of Phase II, two air release valves based on the final design will be delivered to the government.

POTENTIAL COMMERCIAL MARKET: Conceptually the following are possible applications of airbag technology in the private sector. Airbags could be used to supplement or eliminate non-environmentally safe packaging material used in cargo shipping, i.e., polystyrene packaging peanuts, etc. Shipping containers could be developed. Transportation safety crash protection for easily rollable vehicles could be designed using the airbag technology, i.e., moped's, motor scooter/cycles, golf carts etc. Safer cargo handling equipment can be developed using airbag technology, i.e. airport baggage handling, warehousing tractor trailer shipping/receiving systems. Most recently, the Justice Department has an interest in using airbags to restrain captives from excessive movement inside a police vehicle.

U.S. Army Strategic Training Command

A96-090 TITLE: Distributed Interactive Simulation (DIS) Applications for the Combined Arms Tactical Trainer (CATT)

CATEGORY: Exploratory Development

OBJECTIVE: To develop new and innovative solutions specific to CATT problem/ issue areas.

DESCRIPTION: The CATT program is developing a family of interoperable simulators for training a combined arms force in a real-time synthetic environment where the focus is sustainment training for collective tasks and skills in command and control, communication, and maneuver. The Close Combat Tactical Trainer (CCTT) focuses on Armor Close Combat and is the first of the family. CCTT can be represented as five major system elements: 1) manned simulators and staff workstations, 2) semi-automated forces (SAF), 3) DIS compliant network and protocols, 4) after-action review system, and 5) terrain and weapon performance databases.

As the CCTT work progresses and the training requirements become more mature the need for additional technological work has been identified. These needs are outlined below. Potential offerors may submit proposals for any or all of these problem areas.

a. The need exists to incorporate a wide variety of real-world, command, control, communications, computers, and intelligence (C4I) equipment into the CATT synthetic environment. Currently, CCTT has integrated the SINCGARS Radio Model (SRM) developed by CECOM for transmitting and receiving digital voice and data. The initial SRM was computationally intensive and modifications had to be made in order to save computer cycles and allow the SRM to be hosted within the computational resources of individual CCTT simulators. In the future, other C4I systems will be required for integration into simulators, including many of those in the Army Battle Command System (ABCS) including, EPLRS, MCS, MSE, ASAS, etc. The purpose of this effort is to develop an innovative C4I modeling methodology for interfacing C4I systems with a DIS simulation. The Tactical Internet Model (TIM) will be used as a proof of concept in this topic for integration into CCTT. Complementary objectives would include: reducing the computational demand of the SRM, interfacing Applique via an SRM and DIS interface, reducing network bandwidth demand for C4I traffic, and using client server architectures for radio and digital messages.

b. SAF is a key component of the CCTT (and CATT) program. Much effort has been expended in developing and encoding Combat Instruction Sets (CIS) to form SAF behaviors which are verified, validated, and accredited (VV&Aed) and linked explicitly to approved Army doctrine. There is a clear need to capture, reuse, and potentially change the software code associated with a given behavior or set of behaviors. The focus of this effort is to examine this problem and propose methods of capturing and editing the behavior code. If successful, the next step will be to develop a behavior editing tool for creating new behaviors. The tool is envisioned to allow a user (not a software technician) to capture the algorithms and code that execute with respect to SAF behaviors. The tool should work in a run-time environment and work on previously verified, validated, and accredited behavior code. Since, the tool is envisioned for users, it is imperative that this task be abstracted through an easy, intuitive graphical user interface. Training on the tool should be minimized and the tool should not require special hardware to run.

c. The need exists to develop a low cost alternative to the CCTT Commander's Popped Hatch (CPH). The purpose of this effort would be to develop and demonstrate an innovative, low-cost alternative to the CPH. For example a helmet mounted display or virtual reality goggles could be suitable for this purpose.

d. CCTT is using a FDDI Local Area Network (LAN) for distributing DIS packets. The need exists to maximize the number of packets that can be distributed locally over the network. The purpose of this effort is to explore innovative methods for data transfer over a FDDI network. Advances in Asynchronous Transfer Mode (ATM), data compression, and multicasting may have an impact on this problem.

e. After Action Reviews (AARs) are a key component of any training exercise. A need exists for an expert system or intelligent media agent to aid the observer/controller or evaluator to quickly sort and select critical training issues, identify and supply the supporting results and doctrinal reference data, and produce structured AAR media presentations. The purpose of this effort will be to develop a prototype expert system that can capture results data from CCTT PDUs as well as requirements from the Individual Training Support Package (TSP) used to plan and develop the exercise scenario.

f. The need exists to develop and integrate highly efficient algorithms into the CCTT Semi-Automated Forces (SAF). Much of the computational resources available to the SAF system are used in performing routine, repetitive, algorithmic calculations associated primarily with terrain reasoning tasks. The purpose of this effort is to develop innovative methods to improve SAF algorithm performance while minimizing computational load and resources. When improvements cannot be made or are otherwise not available, new methods may be proposed and developed. Algorithms of key interest fall into the following broad categories: terrain assessment, route planning, obstacle avoidance, collision avoidance, intervisibility, identification of cover and concealment, fast, adaptive search algorithms, etc.

g. Existing planning and monitoring techniques and tools available for the execution of research projects contain little or at most a limited capability for managing engineering information sharing between multiple complex projects with numerous contractors located at diverse locations. Projects which implement Concurrent Engineering development processes frequently require significant customer (Government) participation in the Systems Engineering Integration Team (SEIT) and Integrated Product Team (IPT) processes to insure project success at meeting major product milestones. Specifically, existing tools do not allow for centralized control over distributed systems engineering related functions. Additionally, improved methods of disseminating research goals, status and results to other on-going projects are desired. Other systems engineering related improvements are sought and encouraged, and could be the focus of proposed research. For all systems engineering applications, the capability to centrally participate in distributed systems engineering functions is needed, specifically, a process applicable to PM CATT projects and the in place management information system structure. The capabilities could include common databases linked via wide area networks, desktop based video tele-conferencing, improved communications capabilities, and advanced information sharing techniques.

PHASE I: Explore alternative concepts and develop feasible approach.

PHASE II: Implement a best approach from Phase I with the objective of demonstrating the feasibility and effectiveness of the concept.

POTENTIAL COMMERCIAL MARKET: Entertainment industry; commercial simulators such as flight trainers and drivers trainers, video arcade industry, robotics, and system engineering management.

A96-091 TITLE: Advancements in Distributed Interactive Simulation (DIS) Technology

CATEGORY: Exploratory Development

OBJECTIVE: To develop new and innovative solutions to a set of specific problems/technical issues of interest to the Project Manager for DIS.

DESCRIPTION: DIS represents an umbrella concept for future simulations. It includes a synthetic environment within which humans interact through simulation at multiple networked sites using a compliant architecture, modeling, protocols, standards, and databases. PM DIS is actively pursuing the development of advanced technological applications of DIS and has identified several additional areas, described below, currently needing further research. Potential offerors may submit proposals for any or all the areas.

a. The need exists to develop and test prototype architectures to support the integration of Command, Control, Communications, Computers and Intelligence (C4I) operational weapon systems with virtual and constructive simulation. Specifically, integration of real or "live" C4I systems with virtual and constructive simulations in the context of the Defense Modeling and Simulation Office's so-called High Level Architecture (HLA) development is an important application area having at least 3 open technical issues requiring research:

1) representation of information to be exchanged between the "live" C4I systems and virtual/constructive simulations via the HLA Run-Time Infrastructure (RTI),
2) the development of an effective concept for representing and exchanging perceived data between "live" C4I systems and virtual/constructive simulations via HLA's RTI and determination of impacts on system bandwidth requirements, data logging, and after action reviews, and
3) determination of the effects of simulation based events, if any, on the "live" C4I system's performance. During Phase I, an offeror will be expected to review at least 3 candidate C4I system and nominate one to become the C4I "standard" system for the Phase I and II research

b. For large scale DIS applications the need exists for computationally efficient methods of simulating acoustical and electromagnetic (A&EM) propagation realistically in the atmosphere for battlefield scenarios. A technically similar problem, modeling of acoustic energy propagation in the ocean, has been studied extensively resulting in the development of very efficient and effective computational methods. An example is the development of the Parabolic approximation, Split Step Fourier (SSF) algorithm, to the Wave Equation (PE). The PE/SSF solution approach provides an efficient tool for ocean acoustic researchers to obtain solutions to the difficult problems of detection and localization in sonar system designs. It is conjectured that the PE/SSF methodology can be extended to the modeling and simulation of A&EM phenomena with application to large scale DIS exercises. In Phase I, an offeror will investigate the feasibility of extending the PE/SSF method to the propagation of A&EM energy in the atmosphere. Phase II will involve a practical implementation and demonstration for a selected Army application.

c. As the uses and missions of DIS applications mature, there is a need to develop efficient and effective methods for high throughput and low latency communication of encrypted/classified parameters for DIS experiments (to include multi-level security exercises) via the Defense Simulation Internet. In Phase I, offerors should investigate and develop innovative practical techniques or extend existing techniques such as multi-casting, bundling, compression, packet encryption, bulk encryption. Phase II will involve a practical implementation and demonstration for a selected Army application.

d. As the uses and missions of DIS applications mature there is a need to develop analytical tools and assessment system with the capability of analyzing weapon system operation and performance (e.g. missile flyout, and projectile trajectory) during a DIS experiment and after completion of the DIS experiment. In essence we are talking about developing "an after-action-review" capability but in the context of a weapon system development and testing environment. Such a system must apply and implement innovative visualization techniques to data it has collected (it must be capable of processing/interpretation of DIS PDUs at high data rates). In Phase I, offerors should investigate and develop innovative practical concepts. Phase II will involve a practical implementation and demonstration for a selected Army application.

e. There is a need to develop techniques and methods to support the scalability of joint and theater echelon-sized entities to be controlled as computer generated forces for future large scale DIS exercises. Viable techniques/methods must support the transmission of C3I data through varying levels of aggregation and reflects appropriate behaviors at varying levels of aggregation due to inputs of C3I such as situational awareness reports and FRAG orders. In Phase I, offerors should investigate and develop innovative practical techniques and methods. Phase II will involve the implementation and demonstration for a selected Army application.

f. Verification, Validation and Accreditation (VV&A) of synthetic environments may be viewed as the process which provides the scientific basis for the effective use of simulation for training and operational situations. Changes in a model within a simulation now require a complete repeat of the VV&A. This is a time consuming and costly process. What is needed are new and innovative concepts, techniques and methods that will directly address this problem and promote the re-use of existing VV&A models. In Phase I, offerors will develop practical concepts, techniques, and methods. Phase II will involve the implementation and demonstration for a selected Army application.

g. Many constructive simulations are available today that simulate logistics at the strategic level (mobilization, deployment, sustainment). These include entity level simulations of the strategic movement of Army forces and equipment from CONUS installations to the theater of operations. Most of these simulations are for planning and analysis purposes, and are not DIS compliant. Currently there is no requirement for these simulations to be DIS compliant or interoperable. However, it is anticipated that strategic logistics will play an increasingly important role in future large scale DIS exercises. Therefore, the need exists to develop an automated and seamless interface between existing strategic level logistics simulations and DIS compliant systems operating on the DIS network. An interesting and possibly useful concept to consider may be that of an "logistics agent". Such an agent would act as an interface between the existing non-DIS compliant logistic constructive simulation and other entities participating in DIS exercises. It is also envisioned, this agent would act as " a facilitator" in the sense it would permit and support the use of both the training assets of DIS and the planning and estimation assets of constructive logistic simulations in an holistic manner. In Phase I, offerors will explore and develop a practical agent concept. Phase II will involve the implementation and demonstration the concept for a selected Army application.

h. Large scale DIS exercises are extremely complex dynamic domains that require a real time dynamic data base management system (DBMS) to support them. Standard hierarchical relational DBMSs and to some extent object oriented methodologies do not adequately support the problems created by complex data and complex problems all in a real time dynamic synthetic environment. The envisioned DBMS must be able to manage complex data (greater than 5 relationships per entity), within complex problem domains (100,000 or more geographically dispersed independent entities in a synthetic environment), in a

dynamic real time synthetic environment. In phase I, an offeror will Explore, propose and demonstrate feasible new Data Base Management System concepts. Phase II will involve the Development and implementation algorithms and the integration of the same into a designated Army synthetic environment applications.

PHASE I: Develop practical concepts, methods, and techniques.

PHASE II: Implement and demonstrate the results from Phase I.

POTENTIAL COMMERCIAL MARKET: Commercial communication networks; commercial interactive network game/entertainment industry.

A96-092 TITLE: Advancements in Interactive Immersive Dismounted Soldier Training Technology

CATEGORY: Basic Research

OBJECTIVE: To develop new and innovative technological solutions to support the development of cost effective immersive unencumber training for the dismounted soldier in the context of synthetic environments.

DESCRIPTION: Until recently the inclusion of the individual dismounted combatant as a "real" proactive participant in combined arms simulation based training exercises (e.g. SIMNET and DIS exercises) was considered impractical. Advancements in virtual reality (VR) technology appear to have reached a state of critical mass because there are now at least three on-going projects within the DoD that have as their goal the development of an VR based synthetic environment that could support dismounted soldier training. For any of these efforts to be really successful the illusion they seek to create must be sufficient to cause the trainee to suspend believe while in the environment to the extent the trainee believes his action or inactions could cause harm or serious injury to himself or to his comrades. This illusive phenomena is called "presence" and has a sensory component and a functional component. The sensory component has to do with providing the appropriate stimulus to the senses while the functional component has to do with the functionality of other objects in the synthetic environment that the trainee interacts with such as weapons, radios, stethoscopes or any other assortment of "tools" a dismounted soldier might need to his job while in combat. To achieve the desired level of " presence" in the envisioned VR based synthetic dismounted soldier training environments will probably take years of research and development. The goal of this topic is to move the technology in an incremental fashion toward an acceptable state of "presence" in synthetic training environments. Several areas have been identified. Potential offerors may submit proposals for any or all the areas.

a. Body awareness (the correlation between the body we see and feel, and its synthetic representation) in the VR environment is commonly considered to be an important contributor to "presence". Two areas of interest are: low latency unemcumbering holistic full body tracking (head, hands, feet, and torso), and a minimum "foot-print" wireless interface and high bandwidth communication link for soldier worn instrumentation.

b. High resolution visual imagery over a wide field of view is commonly considered to be another significant contributor to "presence". It turns out that high resolution imagery is only necessary over a small region of the field of view. Two areas of particular interest are: a practical ergonomically sound eye tracker compatible with current head mounted displays, and a practical ergonomically sound direct retinal scanning system (note: an eye tracker may be a necessary component of a retinal scanner).

c. Spatial audio is common considered to be significant contributor to " presence". It is not the development earphones and loudspeakers that is needed but rather new and innovative practical approaches for the presentation of auditory information. Sounds must come from the location of the objectives in the synthetic environment. Moreover, it is critically important that this be accomplished in such a way as to provide interactive synthetic environments with real-time rendering of realistic sounds which emanate from complex boundary and environmental conditions.

d. Olfactory stimulus or smells clearly has a definite "presence" role in synthetic environment. An approach that delivers the correct odor at the right time and place with minimum " foot-print" compatible with the synthetic environment is needed.

e. A new and innovative wireless accurate minimum "foot-print" instrumentation concept is needed to track (position, orientation, & key equipment operational events) the dismounted soldiers "tools" in the synthetic environment.

f. Methodologies for rapidly (<48 hours) creating terrain and associated feature databases for dismounted soldier applications with resolutions under one meter (micro-terrain) are needed. Both off-line pre-processing and real-time/on- line methodologies are sought. In addition, the development of an effective methodology for transforming legacy databases into databases with required resolution for dismounted soldier applications.

PHASE I: Explore concepts, methodologies, design possibilities in the above subject areas; develop concepts for each of the relevant possibilities: and show the feasibility for concepts developed.

PHASE II: Taking the results of Phase I, take the most promising concept, design, or approach and develop and demonstrate.

POTENTIAL COMMERCIAL MARKET: The proposed developments would have application in many commercial the entertainment, communications, and instrumentation.

A96-093 TITLE: The Relationship of Physiological and Psychological Effects and Performance/technology within an Immersive Virtual Environment

CATEGORY: Exploratory Development

OBJECTIVE: To investigate relationships between various physiological and psychological effects within the virtual environment with the intention of (1) identifying causal factors, (2) development of new identification tools and (3) minimizing these effects through design or technology.

DESCRIPTION: The virtual environment will attain a degree of sophistication as a result of growth in wide range of technologies, many of which are in early stages of development. Most of these technologies support the stimulations of the senses (seeing, hearing, and tactile feeling) with the goal of making the virtual environment illusion compelling to the point of total emersion. If this endeavor is to be successful system design can not ignore the aspects of human physiology which are relevant to the simulator environment.

PHASE I: Assess, analyze and summarize current research for the purpose of identifying causal factors that may have technological solutions, and identify and develop new tool concepts for analyzing physiological and psychological areas of concern within a research testbed environment.

PHASE II: Develop and validate research testbed.

POTENTIAL COMMERCIAL MARKET: Video arcade entertainment industry; commercial simulators such as individual weapons trainers and SWAT scenario rehearsals. Within the medical community, assists in dealing with phobias.

U.S. Army Tank-Automotive and Armaments Research, Development, and Engineering

A96-094 TITLE: Real-Time Position and Orientation Tracking of Multiple Operator's Line of Sight

CATEGORY: Exploratory Development

OBJECTIVE: Integrate and develop the necessary hardware and software to enable a cost effective wireless, high fidelity six degree-of-freedom tracking of 25 human operator's eye/sensor line of sight, each of which are confined in a small cubicle.

DESCRIPTION: Real-time tracking of the operator's head orientation or sensor line of sight is of critical importance in both the real and virtual environments. A tracking system of high resolution (+/- 0.5 degrees and +/- 1 inch) for the position and orientation of an operator is required for use in live and simulated tests that involve humans. Head tracking to provide the observers field of view provides an additional dimension to observer testing. Knowledge of the observer looking at a target is essential in validating target recognition. Proof of Principle test have demonstrated that head tracking is sufficient for this purpose and that expensive, elaborate, eye tracking systems are not necessary. Current methods, which use short range magnetic fields are not suitable for large numbers of operators in close proximity. The Army Materiel Systems Analysis Activity requires a minimum of 25 operators to provide statistically acceptable data. The operators are normally placed in close proximity to ensure line of sight consistency. A need exists for a tracking system or systems so that up to 25 operators can be tracked in close proximity to one another. The tracking system must have a wireless instrumentation device for the operator with a

minimum operating radius of 2 meters. It must also be lightweight, accurate, insensitive to metallic interference and have a high sampling rate. This system must also operate in a variety of environments from use in simulation labs to covered shelters outdoors to inside vehicles or simulators.

PHASE I: Research and design a system that would meet the criteria stated above. The report should address unit cost along with technical performance specification and operational constraints.

PHASE II: Develop, test, demonstrate and integrate the tracking system for 25 operators.

POTENTIAL COMMERCIAL MARKET: The potential commercial market for the position and orientation tracking system for simultaneous users is applicable to all virtual environment simulation exercises to perception and visualization experiments. Demand for the type of data that this system can provide will increase as more emphasis is placed on the consideration of man-machine interfaces and interface with MANPRINT analysis and simulation.

A96-095 TITLE: Advanced Ground Vehicle Propulsion Technology

CATEGORY: Exploratory Development

OBJECTIVE: The objective is to examine and develop technologies to increase power density with respect to volume and/or weight, increase efficiency, reduce specific heat rejection, and provide reliability improvements for high output military diesel engines.

DESCRIPTION: Anticipated future high output diesel engine operating conditions include cylinder heat loading greater than 4 horsepower (HP) per square inch (piston surface area), 4 cycle break mean effective pressure exceeding 300 psia, and brake specific heat rejection to coolant of 12 BTU per HP-Min or lower. Technology areas addressing these targets as well as that of reducing engine weight include, but are not limited to: 1) high temperature tribology (i.e., tribological system approaches should address high temperature lubricant capability, and friction and wear minimization in areas of borderline lubrication); 2) insulative componentry (i.e., components to be considered shall include pistons, rings, liners, valves, valve guides and seats, head or head combustion face and intake and exhaust ports and novel monolithic and coating applications for these components will be considered); 3) fuel injection system/ combustion enhancement (i.e., technologies to be considered include ultra-high pressure injection or other combustion technologies enabling diesel combustion toward stoichiometric conditions without fuel economy degradation); 4) high efficiency, broad range, low inertia and high tolerance to high exhaust pressure, and concepts to use a turboalternator as a compounding unit are being considered for electric drive applications); and 5) engine lightweight structural concepts (i.e., requirement exists to provide dramatic weight reduction in diesel engine structure and componentry). Also concept designs presented shall be consistent with Army initiatives to reduce operating and support costs. Two generic cost drivers are directly applicable to this topic: 1) causes of electrical/mechanical replacement costs and 2) causes of fuel/fuel distribution costs. It should be noted that the contractor may select component technologies supporting the above overall objective of the advanced diesel engine area. It is not expected that the contractor should necessarily develop a technology system addressing all the areas discussed above.

PHASE I: The contractor shall research technologies and prove concepts from a feasibility standpoint. Concepts designs shall be presented and substantiated via analytical calculations, drawings or in the case of hardware initial bench type testing.

PHASE II: Concepts shall be demonstrated in Phase II using a single or multicylinder engine with operating conditions similar to those of a high output military engine. Steady state as well as transient testing for 100 hours or more may be required.

POTENTIAL COMMERCIAL MARKET: Although commercial and military engines are of different power ratings, the trend for commercial engines is also toward increasing high brake mean effective pressure and higher operating temperature. The engine area of interest presented are all generically applicable to future commercial diesel engines currently under consideration.

A96-096 TITLE: Phase-Change Mechanical Actuators for Ground Vehicle Design Applications

CATEGORY: Exploratory Development

OBJECTIVE: Determine potential applications in military ground vehicles for a class of mechanical actuators which get their driving force from the expansion of solid materials as they melt.

DESCRIPTION: A new class of linear mechanical actuators exists, which combines aspects of solenoids and hydraulic cylinders. A solid polymer, such as polyethylene or a wax, is contained in a hydraulic cylinder. as a polymer is melted by an electric resistance heater, it expands, driving a piston. This principle permits relatively small actuators to provide large forces and controllable strokes. These devices offer mechanical designers alternatives to solenoid and hydraulic cylinder actuators. They may replace solenoids where cost and force are more important requirements than speed. They may also substitute for hydraulic cylinders in locations which are hard to reach with hydraulic lines, but still accessible to electrical wiring.

PHASE I: Study potential military and commercial ground-vehicle applications for current technology phase-change mechanical actuators. Compare phase-change actuators to electrical and hydraulic actuators, in several common ground vehicle applications, such as hydraulic system control and positioning/tensioning devices. Comparisons should account for size, weight, power consumption, actuation speed, positioning accuracy, cost, and installation characteristic. Identify new applications for phase-change actuators, or offer substantial design, cost, performance or durability/maintenance benefits.

PHASE II: Develop and test a phase-change actuator, or family of actuators to serve a military/civilian dual-use application identified in Phase I. the device(s) will be demonstrated in military and civilian vehicle applications.

POTENTIAL COMMERCIAL MARKET: Phase-change actuators will offer designers of all electrical vehicle control systems (such as fly-by-wire) important alternatives to solenoid actuators. They will be an inexpensive means for all electric control systems to generate large forces, if actuation speed is less critical. These actuators will be most important in automotive applications, where electric control systems are increasingly used, and cost is crucial.

A96-097 TITLE: Vision Research and Human Perception for Target Detection

CATEGORY: Basic Research

OBJECTIVE: An investigation of early models of human vision for target detection applications.

DESCRIPTION: The research community has made remarkable progress in its understanding of the early human vision system during the last 20 years. Computational vision models (CVM) use an oriented Laplacian pyramid spatial frequency decomposition as a means to perform a multi-resolution analysis of 2-D imagery. The output from the signal to noise model then inputs to a statistical decision theory module to predict probabilities of detection and false alarm. A missing ingredient in the latter process is the encoding of cognitive information which the human observer uses for higher levels of target discrimination. A major goal of this topic is to investigate the means for incorporating this knowledge into a model of human performance.

PHASE I: Outline a novel approach to accurately predict human observer performance for higher levels of target discrimination with complex target/ background scenes.

PHASE II: Develop a predictive model of human target acquisition performance for low contrast targets which correctly correlates with perception experiments. Calibrate and validate the model for both low and high contrast targets.

POTENTIAL COMMERCIAL MARKET: This human perception modeling research work will support the development of classified signature reduction and the TARDEC/GM collision avoidance countermeasure programs.

A96-098 TITLE: A Numerical Approach for Predicting the Structure Borne Noise of Ground Vehicles Using Statistical Energy Based Finite Elements Analysis (SEFEA) Technology

CATEGORY: Exploratory Development

OBJECTIVE: To develop a numerical approach that can model the behavior of complex structures, such as ground vehicles, by using energy based finite element methods to address the high model density of the structure under analysis.

DESCRIPTION: The finite element method is presently being utilized to compute the structural vibrational behavior of military vehicles. However, these numerical techniques can only perform in the lower frequency range, below 200 Hz. That means that structural information from 200 Hz to 5,000 Hz is not available using standard FEA techniques. Statistical Energy based finite element addresses the higher modal density content of complete military vehicles and extends the analysis frequency range to the higher frequencies.

PHASE I: Develop an energy based finite element formulation applied to a simple military vehicle structure. The method will compute the feasibility of applying this method to the higher frequencies. The method will be verified by comparison to test data for a wheeled vehicle (e.g. a HMMWV).

PHASE II: Extend the frequency limit and apply the method to a more complex structures like tracked combat vehicles.

POTENTIAL COMMERCIAL MARKET: The energy based finite element method would have great potential in the commercial world to more fully understand complex structures.

A96-099 TITLE: Accelerated Corrosion Test Chamber

CATEGORY: Exploratory Development

OBJECTIVE: To develop the critical parameters related to accelerated corrosion chamber development for the early identification and monitorship of corrosion in automotive components.

DESCRIPTION: Automotive components used by TACOM's wheeled vehicle fleet undergo varying degrees of corrosion under harsh operating conditions. A chamber that can simulate the corrosion behavior of the component or the integral system is desired, so that predictability exists for the performance of a system or component prior to full production and deployment in the field. This simulation using the corrosion chamber is expected to save TACOM several million dollars due to early feedback on current and future off-the-shelf acquisition.

PHASE I: Demonstrate the capability to develop a corrosion test chamber that can simulate numerous types of environments on components and integral systems.

PHASE II: Develop a component-sized chamber that can be used for corrosion studies of test components that can be correlated with field observation for corrosion.

POTENTIAL COMMERCIAL MARKET: This chamber will have the potential to be adapted for simulating corrosion over a wide range of industries that include power generation, automotive, aerospace, machine tool and weapons systems.

A96-100 TITLE: Advanced Military Radiator

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this effort is to design, fabricate and test an advanced radiator cooling system for the M109A6 that is more compact and efficient, lighter weight and lower cost.

DESCRIPTION: Anticipate future need for an advanced radiator that is more compact, efficient and lighter weight than the present radiator. The M109A6 cooling system uses a high percent of the engine power to drive the fan. It would be desirable to have an advanced radiator cooling system that is more effective than the current M109A6 cooling system while increasing the performance. To reduce weight of the radiator one approach might be to use lighter weight material such as aluminum. Also the concept design presented shall be consistent with army initiatives to reduce operating and support costs.

PHASE I: In Phase I, the contractor would develop a concept for the advanced radiator and perform testing of that concept in the laboratory. The concept and testing shall be documented in sufficient detail to allow the government to determine if it will satisfy the requirements for the M109A6 and provide the desired improvements.

PHASE II: In Phase II, the contractor shall fabricate and test a breadboard prototype of the advanced radiator. The following items shall be deliverable under this effort: design drawings, test report, final report and the vehicle worthy prototype.

POTENTIAL COMMERCIAL MARKET: Application can include such commercial vehicles as police cars, ambulances, fire trucks, or other vehicle exposed to rough field usage. This technology could lead to a reduced operating and support (O&S) cost for any vehicles exposed to rough field usage.

A96-101 TITLE: Optimization of the Spatial Arrangement of Reflectance Points for a Global Reflectance Model

CATEGORY: Basic Research

OBJECTIVE: Develop the optimum arrangement of reflectance points on any given vehicle geometry for a Bi-directional Reflectance Distribution Function (BRDF) based reflectance model.

DESCRIPTION: A reflectance model can be broken into two parts, a local reflectance model and a global reflectance model. The local model is based on a Bi-directional Reflectance Distribution Function which quantifies the amount of specular and diffuse light reflected from a particular point. The global model incorporates many reflectance points together along with the environment to give the total luminance to an eyepoint. Too many reflectance points is not practical due to computation times, so the question arises how to best arrange these reflectance points on a modeled vehicle to minimize the error and run-time.

PHASE I: Determine the optimum arrangement of reflectance points where run-time and error in luminance for a given vehicle geometry are simultaneously minimized.

PHASE II: Model a vehicle with various reflectance point arrangements and resolutions and develop an automated approach in C++ at finding the optimum reflectance point arrangement for that vehicle. The optimization criteria must work for a general vehicle model with the effects of a camouflage pattern considered.

POTENTIAL COMMERCIAL MARKET: There is dual-use potential in the Architecture and Film communities where interior and exterior modeling of light is used to communicate ideas and proposals. Other opportunities lie in the surface optics community. Simple ray tracing approaches do not consider light in a physically reasonable way.

A96-102 TITLE: Validation Analysis System for Crewstation Simulators

CATEGORY: Exploratory Development

OBJECTIVE: To develop a validation analysis tool to handle the widely varied requirements of crewstation simulators.

DESCRIPTION: The Army is currently investing in the development of new class of simulator, the crewstation simulator. They place soldiers in simulated combat vehicles, where they interact with their environment and other simulated entities (through the Distributed Interactive Simulation, DIS< network). The DoD has set ambitious goals for its crewstation simulators, they are to be of sufficient fidelity and correctness to allow important decisions (battlefield tactics, design, procurement) to be made. Due to the breadth of the simulation (almost all aspects of a vehicle are simulated) and the disparate nature of the elements to be simulated (a Soldier Machine Interface simulation is dramatically different from a vehicle dynamics simulation), determining correctness is very difficult. The objective is to develop a suite of analysis tools (developed, purchased, or public domain) that mirror the non homogenous nature of the simulator, but are integrated such that they work effectively together. The ultimate goal is to utilize this suite to validate the performance of constructed simulators. Crewstation simulators are constructed such that they can simply record a large set of their internal workings; continuous data (like an oscilloscope), event data (like a timeline), histograms, etc. This data is recorded in simple, generic ascii formats; and forms the basis for all analysis. The results of analyses should be stored in a system that allows ready access to them, and related results; a configuration management system. Examples of elements to be compared to reference data and analyzed are: 1) Vehicle/turret/gun motion; 2) Propulsion system performance; 3) Soldier Machine Interface (SMI) performance; 4) Weapon system performance (missiles, guns, ballistics, etc.); 5) DIS compliance. Because of the ever changing nature of the crewstation simulation, it is desirable that the analysis be readily adaptable to different situations.

PHASE I: The goal of Phase I is to fully develop the system concept, perform significant design, and possibly to prototype a portion of the system.

PHASE II: The goal of Phase II is to develop a system as describe above. In order to insure usefulness, it is expected that the user will be continually providing feedback during its implementation, possibly by testing intermediate version.

POTENTIAL COMMERCIAL MARKET: The test analysis system will of course be applicable to the development of commercial products such as flight and automotive simulators. However, the test analysis system is intended to be one piece of much larger set of tools, with a development process built around the tools. This development process is specifically designed to handle the construction of complex systems, systems that are readily found commercially. It is the intention of the Army to promote this development process (with tools), and to distribute it to institutions where it can be applied.

A96-103 TITLE: Low-Cost Titanium Tow Bar

CATEGORY: Exploratory Development

OBJECTIVE: Develop, design and investigate low-cost manufacturing and processing using low-cost titanium alloys to make tow bar lighter and cost competitive with the new M1 steel tow bar.

DESCRIPTION: Titanium alloys have higher strength-to-weight ratio than steels. However, higher cost of titanium alloys has prevented its use in automotive and military ground mobility vehicles. Titanium companies have developed lower cost titanium alloys which offer the potential for reducing automotive and military component weights such as springs, torsion bars, tow bars, etc. at a cost that is competitive with steels.

PHASE I: The contractor will evaluate low-cost titanium alloys for M1 tow bar maintaining commonality of attachments to the vehicles. Evaluate manufacturing processes, joining processes, post processing, material properties, and cost. Conduct trade-off studies to formulate the most cost-effective solution. Conduct lab testing of the selected material and process for the design of the tow bar in Phase II. A final report will document the results and compare the cost-effectiveness to the new steel tow bar and directions to be taken to make it cost competitive to steel tow bar.

PHASE II: The contractor will design the low-cost titanium tow bar from the properties established in Phase I. Contractor will manufacture a number of tow bars for testing at proving grounds. Analysis data. Conduct failure analysis. Redesign and fabricate if necessary.

POTENTIAL COMMERCIAL MARKET: The evaluation of low-cost titanium from the standpoint of their use for automotive and military applications is of substantial interest to the commercial automotive industry. This effort would benefit both the automotive industry, as well as the military market.

A96-104 TITLE: Advanced Armor Vehicle Design

CATEGORY: Advanced Development

OBJECTIVE: To combine a capability (develop under an earlier contract) to evolve an optimum armor design by employing Artificial Neural Networks (ANNs) and a genetic algorithm using these ANNs with a 3-D ray tracing program such as BRLCAD to achieve an advanced vehicle hull design that is optimized for armor within constrains for weight and cost.

DESCRIPTION: During the last several years, under a TACOM contract, several branches of artificial intelligence have been successfully combined to produce a computer program that designs optimal armor configurations given an ensemble of threat munitions and armor weight constraints. The program utilizes artificial neural networks (ANNs) trained to understand armor design by using field test data and a genetic algorithm that uses these AANs to evolve an optimum an optimum armor design. In this process many thousands of armor designs are generated, evaluated, and either rejected or their best features combined to produce ever better designs. To our knowledge this is a totally new development concept which appears to hold great promise in future design efforts. It is now desired to combine this with a DAD process to design a vehicle that carries forward the results into a vehicle design.

PHASE I: Phase I would consist of the following steps: 1. Identify the CE, KE, and EFP threat munitions to be used against the vehicle. 2. Identify the envelope of possible azimuth and elevation angles of attack with respect to the vehicle for each munition. 3. Identify all the candidate armor that will be evaluated against the threats. These can include reactive, passive (including vehicle structure) and combination of these. The candidates could include off-the-shelf tested designs, designs optimized against specific threats as described in the TACOM effort above, proposed contractor designs, etc. 4. Use a 3-D ray tracing program such as BRLCAD to construct approximately 100-200 rays passing through the crew compartments and covering the envelop mentioned above. Probabilities can be assigned to each of these rays to distinguish likelihood of top attack vs. frontal attack, side vs. front glacis attack, etc. Possible munition types are assigned to each ray together with the probability of use of given munition. 5. A total weight budget can be assigned to the vehicle. Using a composite of all the ray data, a genetic algorithm is then used to evolve the optimum armor types and placements on the vehicle in order to achieve the maximum crew protection within the total weight budget allowed for the specified threat suite.

PHASE II: Phase II would consist of fabricating a hull or a mock-up of the resulting Phase I design and validating the optimized design by subjecting it to ballistic test.

POTENTIAL COMMERCIAL MARKET: Validating of the method would open the way to optimize other vehicle designs where there are many input variables with numerous constraints. Classical optimization technology is simply not able to deal with such a complicated problem with finite computer resources. Our experience in the last three years has been that genetic algorithms offer the only hope of achieving near optimum results when confronted with many variables, all of which must be considered in arriving at the solution.

A96-105 TITLE: PRISM, SPIRITS and GTSIMS Compatibility

CATEGORY: Exploratory Development

OBJECTIVE: To allow SPIRITS to take advantage of the image based systems capabilities within PRISM, incorporate plume technology from SPIRITS into PRISM for ground combat target and helicopter use, and to allow both of them to be capable of fully utilizing GTSIMS (DISAMS, etc.).

DESCRIPTION: GTSIMS is a missile engagement model that incorporates signatures of targets and backgrounds into a simulation. PRISM and SPIRITS have long been accepted thermal signature models for ground targets and air targets respectively. By allowing PRISM and SPIRITS to interact with GTSIMS, the power of three respected models will be brought together. PRISM and SPIRITS would both be modified to allow direct feed into GTSIMS. In addition, the Image Based System (IBS), which is found exclusively in PRISM, has proven to be a powerful methodology for rapidly calculating radiation shape factors with high precision. In order for this method to be extended for use in air targets, the solution method requires expansion, so that large high resolution models (over 30,000 elements) can be used in signature prediction and then it must be modified for use in SPIRITS. SPIRITS would benefit greatly from this improved capability. And finally, although its signatures for vehicle surfaces (skin) and engine hot parts have been extensively validated in PRISM, any gas emissions from exhaust are not included in the signature prediction. One of it's weaknesses is the lack of a plume model. There are, however, accepted plume codes found within SPIRITS that could be adapted for ground vehicle and helicopter analysis. These changes would allow engineers to use SPIRITS for aircraft and PRISM for ground targets and helicopters in a more accurate and efficient manner.

PHASE I: Investigate the required interconnections between the models and set up the framework for the integration, adapt IBS for larger models and provide a stand-alone capability for use in SPIRITS, and investigate axial and non-axial plume models for the requirements to integrate a plume signature into a PRISM vehicle signature.

PHASE II: Finalize the integration of the models, fully integrate the IBS methodology into SPIRITS, and fully incorporate the plume code into PRISM while complying with the needs and goals of both the Multi-service Electro-optical Signature (MuSES) Code Consortium and the Electromagnetic Code Consortium (EMCC) thermal subgroup.

POTENTIAL COMMERCIAL MARKET: An easy-to-use thermal model with simulation, an emphasis on quick radiation, and the ability to utilize plumes has dual use potential in automotive applications as well as civil engineering applications. The simulation capability of GTSIMS coupled to thermal signature models could provide important collision avoidance studies for testing new onboard sensors on automobiles or other commercial vehicles (including aircraft). The temporal simulation of thermal effects could also be used for roads and bridges to predict (and warn of) freezing conditions based on environmental inputs. An easy-to-use thermal model with engine exhaust plume capability has dual use potential in automotive applications where engine models and computational fluid dynamics (CFD) analysis are used for assessing performance and heat management concerns.

U.S. Army Test and Evaluation Command

A96-106 TITLE: Ultra High Resolution Digital Cameras

CATEGORY: Exploratory Development

OBJECTIVE: Using large format extremely high pixel density (e.g. greater than 25 million pixels) CCD sensors or equivalent devices, new or novel techniques are sought for ultra high resolution to digital cameras that will yield less than a one percent resolution degradation in comparison to standard film cameras.

DESCRIPTION: Images stored on film currently represent the highest resolution available for the collection of photographic data. Although standard video techniques are in widespread use, when high resolution images are required film is the technology

of choice. Despite the excellent resolution presented by many films today, they possess several drawbacks which include relatively high cost, fragility of the film, processing delays, no real time display capability, no direct means of digitizing images for computer processing without resolution loss, cumbersome methods for acquisition and viewing, and others.

This task will extend current technologies or develop new technologies for the acquisition of visual imagery that will rival or exceed the resolution of conventional film. It is highly desirable that the developed technology provide for short exposure durations and relatively high framing rates (on the order 1ms and 400 frames per second) as part of the camera systems capabilities. Additionally, the developed technology shall be such that it will have the potential for the commercial market at competitive cost levels. The recording and display media shall be given equal consideration to that of the actual cameras.

PHASE I: Investigate new or novel techniques for ultra high resolution digital imagery. The end result of the investigation shall be the identification of the selected technology that will yield the desired image resolution. The investigation may entail the actual laboratory demonstrations of various technologies and techniques. Should an extension of existing technologies be considered unusable, the investigator shall develop a detailed design analysis for a new or divergent technology that will yield the desired results.

PHASE II: The investigator shall develop and deliver to the government a complete functional prototype system as defined and approved in Phase I. The contractor shall fully characterize the camera and conduct field tests at the government sponsors facility.

POTENTIAL COMMERCIAL MARKET: The commercial market is constantly striving to improve the quality of video products available to consumers. The dramatic improvement to the resolution of video systems that this SBIR may yield may be opened up to a tremendous commercial market that will range from average consumers to major corporations.

A96-107 TITLE: Precision Target Ballistic Scoring System

CATEGORY: Engineering Development

OBJECTIVE: Produce a capability to measure yaw, tumble, angle of arrival and projectile velocity of subsonic and supersonic projectiles.

DESCRIPTION: Automatic computerized system capable of precisely scoring subsonic and supersonic projectiles or particles singly or in bursts. Projectile sizes will range from 0.22 caliber to 120 mm cannon shells. Shall be capable of calculating and displaying a single projectile scoring within 30 seconds. Shall be capable of recording and scoring and displaying 100 round bursts within 2 minutes. Typical burst rates are 675 rounds/minute for 30mm and 1100 rounds/minute for 20mm projectiles. Shall be capable of accuracies to 0.050 inches and target size to 25 ft square. In priority order, it is desired that the system shall be capable of measuring yaw, tumble, angle of arrival, and projectile velocity at the target location during Post Processing. System should not be degraded by changes in humidity, temperature, barometric pressure, wind or ambient light. System must be capable of operation in severe desert environment. System setup and calibration requirements must require less than 1 hour and be maintained for 8 hours. System must be capable of remote operation with Control, Display and Data Storage Units up to 3-5km from target scoring area. Lightweight cable or FCC free RF communications desirable. System should be capable of generating standard ballistic statistics, XY, time, time at target, dispersion, high and low velocity and velocity dispersion.

PHASE I: Breadboard system and supporting analysis.

PHASE II: Single Station system demonstrating all intended measurement capabilities.

POTENTIAL COMMERCIAL MARKET: Measurement, processing and communications technologies produced by this effort would have wide application to civilian robotics, security systems and data processing systems.

A96-108 TITLE: External Initiation System with Internal Crush Switch

CATEGORY: Advanced Development

OBJECTIVE: Develop and demonstrate a rail mounted system capable of initiating multiple warheads, on a moving missile system, while utilizing the missile's internal crush switch.

DESCRIPTION: Missile systems contain tandem warheads that are designed to defeat reactive and active armor targets. When dynamically launched on a rail, a missile must be modified to permit the initiation of the warheads. In the case of tandem warheads this requires installing high energy detonators and installation of an initiation system. The initiation system has historically been one of two types: 1) an internal system that rides inside the surrogate missile body and utilizes the missiles internal crush switch. The main advantage of this system is the use of the tactical crush switch. The disadvantage include poor reliability, high cost per circuit and lack of timing data (unless a high cost telemetry package is added) or 2) an external system that is located near the target and utilizes an external crush switch. The main advantages of this system are low cost, easy data retrieval, and high reliability. The main disadvantage is the mounting of an external crush switch which changes the tactical configuration of the missile system and biases the test results. The ideal system would have the benefits of the external system (low cost, high reliability, and easy data retrieval) and the benefits of the internal system (use of the tactical crush switch).

PHASE I: Investigate new and innovative ways to develop an external firing system and utilize a missile's internal crush switch.

PHASE II: Implement the design concepts by manufacturing hardware and testing it in a controlled explosive test conducted by the government.

POTENTIAL COMMERCIAL MARKET: This device may be used by the mining or construction industry where precise timing of explosives is required for demolition or construction.

A96-109 TITLE: Damage Detection in Thick-Walled Composites Using Surface Mounted Piezoelectric Elements

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate a piezoelectric element transducer system for composites damage detection.

DESCRIPTION: Thick-walled composite structures (one inch thickness or greater) have particular susceptibility to damage, such as delamination and matrix cracking, under the action of residual stress developed during fabrication. This damage can be present before the structure is subjected to any external load whatsoever. Consequently, a reliable method is needed to check for damage prior to placing these structures in service. The method should be nondestructive and should be convenient enough to use on 100% of the items produced. The method proposed is based on removable surface-mounted piezoelectric elements. These highly sensitive elements should be able to detect delaminations by changes in response to vibratory excitations introduced by methods of controlled impact (free vibration) or surface excitation (forced vibration). Sensitivity, reproducibility and ease of operation are evaluation criteria for the proposed excitation approach.

PHASE I: Investigate new and innovative ways to apply surface mounted piezoelectric technology to damage detection problems. Ideal result is a sensitivity demonstration for flaw detection in thick composites.

PHASE II: Implement the design concepts by manufacturing a fully automated damage detection capability suitable for operation at the technician level. Successfully perform complete acceptance tests upon delivery at the government sponsor's facility.

POTENTIAL COMMERCIAL MARKET: This device may be used throughout the composites manufacturing industry.

A96-110 TITLE: Passive Sample Technology Development

CATEGORY: Advanced Development

OBJECTIVE: Passive samplers have been used in industry for air safety monitoring of hazardous chemicals. The military has a passive sampler requirement for measuring chemical simulant vapor concentration (methyl salicylate) under nuclear- biological-chemical protective light-weight clothing. Commercially available samplers have been alveolate according to the following criteria; cost of sampler, protrusion height, theoretical diffusion characteristics, contamination potential, durability, precession and accuracy, and sensitivity. Methyl salicylate has been absorbed on Tenax TA sorbent material, concentrated on an automated thermal deception system, and analyzed by gas chromatography. In order to meet the customer test requirement, the precision and accuracy of passive sampling must be improved and the presence of interfering substances must be reduced. The current level of detection is 1-2 ng/sampler. Proposals are requested to improve passive sampler technology. Emphasis should be placed on passive sampling devices that can achieve real time vapor monitoring.

PHASE I: Investigate new or novel techniques for passive sampling of hazardous chemicals. Results of the investigation shall be the identification of the selected technology that will produce improvements over existing capabilities, especially with regard to vapor monitoring in real time.

PHASE II: A complete functional prototype sampling capability will be delivered to the government in accordance with the results of Phase I. The contractor shall fully characterize the sampler and conduct field tests at the government sponsor's facility, to include a real time monitoring demonstration.

POTENTIAL COMMERCIAL MARKET: Improvement will be made in passive sampling technology which may allow for real time vapor monitoring. There may be substantial safety advantages in having a commercial real time vapor monitor when workers go into a hazardous environment during a large spill clean scenario.

A96-111 TITLE: Techniques for Assessing the Visual Quality of Digitized Imagery

CATEGORY: Engineering Development

OBJECTIVE: Develop a methodology and automated techniques for assessing the quality or fidelity of digitized imagery with respect to the human visual system.

DESCRIPTION: As the use of digitized imagery becomes more prevalent on the battlefield, a method for assessing the quality or fidelity of the imagery becomes increasingly important. Loss of image quality is particularly notable after an image has been compressed and reconstructed using one of the current compression methods such as JPEG, wavelet or fractal. In general, the higher the compression ratio the more lossy the image is after reconstruction. In critical applications, such as in the medical field, the quality of imagery is extremely important, so a lossless compression method in needed. In less critical applications, a lossy compression system can be more easily tolerated, but only to a point. Thus, the amount of loss in image quality or fidelity that can be tolerated, in a given application, is an important measure. Developing an automated method for assessing image quality is the primary goal of this effort. Once developed the method can be applied to assessing images collected from remote sensors, electronic camera systems, and other digitized imaging systems.

PHASE I: Develop the baseline methods, algorithms, and criteria for assessing image quality.

PHASE II: Implement these methods in hardware or software and demonstrate the systems using various digitized images selected by the government. After instructing government personnel on the operation and use of the system, the system will be turned over to the government.

POTENTIAL COMMERCIAL MARKET: The methods for assessing digitized imagery quality can be used in any of the following commercial applications: digital laser discs, electronic camera systems, video teleconferencing, and interactive video on personal computers.

A96-112 TITLE: Small Arms Scoring System

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate a small arms scoring system capable of recording the impact coordinates of all types of small arms ammunition at multiple firing rates ranges.

DESCRIPTION: The Small Arms Branch of ATC is currently charged with conducting dispersion testing on various small arms weapons and ammunition requiring various target ranges and rates of fire. The current system used is the Oehler 82 Acoustic Scouring System. This system uses the projectile shock wave for determining impact coordinates. The system is thereby limited by the strength of the shock which in turn relates to target range. In addition, this system is extremely sensitive to temperature and humidity changes which can adversely affect accuracy of the data. Increases in current ammunition technology are resulting in increases in ammunition effectiveness. This has pushed the range at which dispersion testing is conducted beyond the current capabilities of the existing system. In addition, future developments in small arms ammunition will not be able to be accommodated by the current system. New developments in low velocity bursting munitions technology are to be tested at ATC in 1997 and will not be compatible with the current system. A new means of scoring small arms ammunition is needed. The system must be capable of handling both low and high velocity munitions from.22 caliber to 40-mm. One technology that may be explored would be a system using eye-safe LASER's similar to current scanners. Minimum performance specifications are

the following: +/- 1 mm scoring accuracy, target size: 10' x 10' portable and 30' x 30' stationary, and projectile velocities ranging from 200 m/sec (75 m/sec desired) to 1550 m/sec.

PHASE I: Investigate new and innovative ways to record the impact coordinates, process and produce detailed output for small arms ammunition and weapon testing. The design must consider that the system will be used outdoors, under various temperature and humidity condition. The system must be able to score rounds using multiple targets and ranges, and should accommodate different ammunition dispersion characteristics.

PHASE II: Implement the design concepts by manufacturing hardware and testing it in a controlled test conducted by the government. Multiple calibers of ammunition varying in velocity and size would be tested.

POTENTIAL COMMERCIAL MARKET: It is plausible to expect that this effort may produce a more cost effective, as well as more accurate means of scoring small arms impacts. In that event, a significant commercial indoor and outdoor firing range market would likely take advantage of the new technology.

U.S. Army Corps of Engineers Research Laboratory

A96-113 TITLE: Affordable Sensing Technologies for Infrastructure Condition Assessment

CATEGORY: Engineering Development

OBJECTIVE: To develop and demonstrate affordable integrated sensor configurations which will automatically collect data on the condition/health of a target infrastructure system or component, such as building, roof, foundation, bridges, pavements, navigation locks and dams, and underground utility systems. Sensor configuration proposed should be affordable and reliable to operate, and provide complete automated inspection capabilities for specific types of structures or components.

DESCRIPTION: Recent advances in microelectronics and sensing technologies permit sensing various types of failures/distresses in infrastructure systems and their components. Off-the-shelf sensing systems, however, are of a single purpose, measurement specific type, like temperature, moisture, position/displacement sensing, etc. Sensing the condition of infrastructures, on the other hand, typically requires data from a multitude of specific purpose sensors to provide meaningful condition information. Such integrated sensor packages are not available for infrastructure inspection areas, and often are cost prohibitive.

PHASE I: Develop the design concepts necessary to provide complete condition inspection data for targeted infrastructure system or component. Target structure may consider buildings, roofs, building foundation, pavements, airfields, bridges, navigation locks and dams, and underground utility distribution systems (water, sewer, gas steam lines). Design criteria should include the sensing challenges of the target infrastructure/component, critical measurement types required, sensor fusion requirements, and operation costs.

PHASE II: Develop prototype sensor packages. Field test sensor packages at an Army installation.

POTENTIAL COMMERCIAL MARKET: A very high commercial potential. A very large market exists for proven sensor packages for automated infrastructure inspection. This includes private building/plant owners, and state and local governments.

A96-114 TITLE: Rule-based Agents for Knowledge Worker System

CATEGORY: Exploratory Development

OBJECTIVE: Develop an innovative software application that is fully integrated with the Knowledge Worker System (KWS) that allows KWS users to define and use rule-based agents that perform a variety of personal and work flow functions in response to KWS system events such as receiving messages and task assignments, marking tasks as past due, etc.

DESCRIPTION: In 1987, it was estimated that 50 million white-collar knowledge workers in the U.S. were paid more than $1 trillion in salaries with these numbers increasing each year since, indicating a great incentive to improve knowledge worker productivity. The U.S. Army Corps of Engineers Construction Engineering Research Laboratories (USACERL) has developed KWS to help knowledge workers organize, learn priorities, and execute their work in the most efficient way possible. KWS provides an integrated, computer-based environment that enhances employee productivity by delivering task-specific information as needed. KWS can be compared to an electronic desktop that organizes all the tools the worker needs for each task. Its master calendar links knowledge workers whose tasks are interconnected. This calendar can update milestones, status information, and

priorities to assist work groups in task prioritization and coordination. A software application is needed that integrates completely with KWS, running under Microsoft Windows 3.1, that allows users to define rule-based agents using a set of predefined agent functions that can be selected from a list and entered into rule-editor dialog boxes. A capability must be provided to group these rule-based agents into agent sets and the knowledge worker should be able to easily activate or deactivate agent sets using an agent manager. The agent manager should show all defined agent sets, the agents within each set, and the status (activated or deactivated) of each agent set.

PHASE I: Develop a set of actions and functions corresponding to KWS system events that can be used to define rule-based agents, demonstrate that the agents developed execute accordingly based upon system events that occur during a KWS session, and show that sets of agents can be activated or deactivated at will using an agent manager interface.

PHASE II: Develop a prototype rule-based agent application that is fully integrated with KWS, including a comprehensive set of network-based, Windows-based, and KWS system event actions and functions that can be used to design rules, and provides all of the application features described in Phase I.

POTENTIAL COMMERCIAL MARKET: Should a rule-based agent application be developed for KWS with technology such that its basic concepts and code could be used and integrated with other software applications, every software development firm with interests in integrating intelligent agents into their applications would be a potential buyer of this product or technology. Therefore, there is a high potential for commercialization.

U.S. Army Cold Regions Research and Engineering Laboratory

A96-115 TITLE: A Coherent FM-CW Radar for Continuous Geophysical Profiling Deployed on a Remotely Piloted Aircraft

CATEGORY: Engineering Development

OBJECTIVE: To develop a high resolution, coherent FM-CW continuous profiling radar system mounted on a small, inexpensive, easy-to-operate airborne remote controlled platform.

DESCRIPTION: Geophysical radar technology and remotely piloted vehicle (RPV) technology have made significant advances in recent years. The combined utilization of these two technologies has much potential for commercial and military applications. Currently ground- and airframe-mounted FM-CW radars are commonly used for many commercial and military related geophysical surveys, surveillance, and research efforts. However, these manned vehicle applications require significant capital investment, are expensive to operate and maintain, may require special certification or license, and are unsuitable for operation in at-risk environments. To overcome these limitations, a lightweight coherent FM-CW radar mounted on a small, inexpensive RPV is required. Initial applications pertain to measurements of ice and snowcover characteristics. However, future applications to subsurface sounding, bathymetry, soil constituency, vegetation, and infrastructure are inevitable and may require a variety of modified/new radar sensor arrangements. Therefore, a modular implementation of the RPV/sensor system would be advantageous. Desirable radar system characteristics include: lightweight, compact, centimeter resolution, 100 meter maximum range, greater than 25 scans per second repetition rate, less than 5 degree beamwidth, and coherent detection and processing. Desirable remotely piloted aircraft capabilities include: capability to hover, airspeed up to 50 mph, a usable altitude of 2 to 100 meters AGL (above ground level), greater than 1 hour flight duration, line-of-sight control, additional sensor payload capability, low operator training curve, short wingspan/rotor span, low cost, and simple maintenance, launch and recovery procedures. The RPV should be of a compact, transportable design. Desirable down-link telemetered data include: real-time radar data, GPS positioning information, down-looking video.

PHASE I: Demonstrate feasibility of coherent FM-CW continuous profiling geophysical radar with air-to-ground telemetered data and on-ground real-time processing and display. Demonstrate feasibility of a small, remotely controlled aircraft capable of carrying a radar system payload.

PHASE II: Develop, test, and modify (if necessary) a practical prototype system.

POTENTIAL COMMERCIAL MARKET: This radar system could be used to enable safe river and lake ice thickness measurements, to enable navigation season extension in ice-affected rivers, to determine location of liquid water in Arctic regions, to determine snowcover thickness and stratigraphy for hydrological and watershed assessments, to conduct trafficability studies over natural terrain, and to conduct hazardous/toxic/denied environment surveys.

A96-116 TITLE: In-flight Aircraft Icing Prediction Detection System

CATEGORY: Engineering Development

OBJECTIVE: Develop a remote sensing prediction detection system with real-time cockpit display that maps airframe icing potential (magnitude and location of supercooled liquid water and drop size range) in three-dimensional space up to ten nautical miles ahead of an in-flight aircraft. With the information provided, a pilot could avoid areas of high airframe icing potential and be advised how to escape icing after penetration.

DESCRIPTION: Large areas forecasted for aircraft icing do not usually produce continuous airframe icing. Instead, icing occurs discontinuously with areas of little or no icing, punctuated by areas of moderate to severe icing. Forecasters do not have the skill or tools to provide spatially detailed aircraft icing forecasts. As a result, pilots usually do not know they are in serious icing conditions until aircraft airworthiness deteriorates. One solution to this problem is to place a remote sensor system on aircraft to locate areas of supercooled liquid water in the flight path. The system could create and display in real-time a map of airframe icing potential ahead of the aircraft. This would enable the pilot to change course to avoid or escape icing. The system would provide information to pilots in a manner conceptually similar to that provided by current airborne instruments that locate thunderstorm cells and wind shear ahead of aircraft. The system should warn of in-cloud icing potential and specifically identify freezing rain or drizzle (large droplets) in the flight path. The system must scan the amount and location of liquid water and its temperature up to ten nautical miles ahead of the aircraft from within clear air or clouds. In its final configuration the instrument should have an onboard processor to map real-time icing potential in a volume of air ahead of the aircraft and display it in a manner consistent with efficient cockpit management. Two technologies with prediction detection system potential are differential attenuation radar and multiple field of view (MFOV) lidar. Radar's advantage is its ability to penetrate clouds. An advantage of MFOV lidar is its ability to detect cloud droplet spectra. Disadvantages of lidar are its potential threat to eye safety, and its inability to cope with clouds of high optical depth. Both have weight, size and power disadvantages. Preferably, implementations of these technologies, alternative technologies, or fusions of several technologies will be integrated with existing and developing airborne weather and wind shear detection systems, creating one multiple use system.

PHASE I: Demonstrate feasibility, preferably with laboratory or field experiments, of remotely locating and quantifying cloud and precipitation phase, temperature, liquid water content, and drizzle and rain drop size spectra. Demonstrate feasibility of extending range to ten nautical miles, and for measuring from clear air to within clouds, and from within clouds to adjacent clouds. Capabilities should be verified with independent measurements.

PHASE II: Develop prototype system to demonstrate ability in wide range of in-cloud and precipitation icing conditions. Verify in-flight ability to remotely locate and quantify cloud and precipitation phase, temperature, liquid water content, and drizzle and rain drop size spectra in real-time to ten nautical miles, and demonstrate cockpit display. The system must pass applicable FAA and military certification requirements.

POTENTIAL COMMERCIAL MARKET: General aviation aircraft, helicopters, commuter aircraft and commercial jets need such a system. The system would extend operating conditions for all-weather helicopters and fixed-wing attack aircraft and improve safety and military readiness. The system could assist self-navigating smart weapons, and could be located at airports and on ships that launch and retrieve aircraft.

U.S. Army Topographic Engineering Center

A96-117 TITLE: Rapid Database Transformation for Modeling & Simulation

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this project is to design a system to rapidly construct databases for use in a variety of modeling and simulation systems. Models & simulations are increasingly being used to support contingencies/force projection (hot spots). Information must be current and database production and transformation methods must support rapid turn around. Near term goal is one week. Objective goal is forty-eight hours. Outputs must be compatible with existing mission planning (TEM/DTSS/SPARTAN) and with emerging wargaming or constructive simulation models like WARSIM 2000 in terms of database format, resolution, accuracy, content etc. This will promote correlation and interoperability between operational planning systems and the training or mission rehearsal system.

DESCRIPTION: The primary shortfall/bottleneck is rapid construction of high quality, current databases. The starting point should be standard Defense Mapping Agency (DMA) Digital Topographic Data (DTD). Specifically, high quality Interim Terrain Data (ITD), and 30 meter Digital Terrain Elevation Data (DTED) Level II from DMA, are used as the basic foundation. Enhance and value add with imagery, maps, all source material, to fill in the level of detail needed for the specific mission. The other critical shortfall is rapid transformation of the data. Image generators and high end workstations require data in specific formats for realtime simulation and fly through. The data is usually in a polygonal format. Textures are added which can be generic, photo source, and can be geo-specific. Highly detailed 3-D models of other natural and man made features like trees buildings, bridges, and roads are typically included. There is also a current shortfall in simulations in representing realistic physics based environment and terrain models. What has been done to date is primarily an artistic representation of the world. What needs to be done is to realistically reflect the world using physics or physically based models. Another problem is maintaining an accurate and consistent geodetic reference. Especially for mission planning applications the true geographic coordinates and representations in the simulation are critical to successful mission rehearsal and execution.

PHASE I: Develop a detailed system design needed to implement and demonstrate a system which uses the following basic guidelines, but is optimized to meet the 48 hour turn around requirement. Guidelines: Use standard digital topographic data (DTD) to the fullest. When not available, use a state-of-the-art photogrammetric exploitation system to generated DTD. In both cases use available systems to enhance/value add from controlled imagery and collateral sources. Standard and custom data must then be transformed into a format acceptable by the image generator for simulation. Use a commercially available geographic information system (GIS) as a transformation tool to tailor the data. Tailoring includes seaming, thinning, generalization, value adding additional features, conversion to the desired polygonal format, and preserving the feature attributes necessary for the simulation. This data is then exported to the image generator front end for additional enhancement. Loral (BBN SIMNET) and Evans & Sutherland (CCTT) use their own custom database modeling packages to make the textures/models and populate the database (S1000 & EaSIEST). Within these packages textures/models are added along with other specialized information needed for the simulation. Because building 3-D models is labor intensive, using a standard model library can avoid duplication of effort, promote re-use, and limit future model production to those custom models/features for the specific mission.

PHASE II: Implement and demonstrate the detailed design developed in Phase I.

POTENTIAL COMMERCIAL MARKET: Phase II potential should be very high Commercial applications of a system with capabilities described above could include disaster relief, environmental monitoring and restoration, training for hazardous waste removal, city, highway and construction planning. This system could be used to model and analyze any type of setting or environment with the advantage of being safe, low cost and with no environmental impacts.

A96-118 TITLE: Climate Spreading Methodologies

CATEGORY: Exploratory Development

OBJECTIVE: Research current methodologies for the spreading (interpolation/ extrapolation) of terrain and climatic information. Develop empirical methods (geostatistical, inferential, rule-based) that allow the spreading of various terrain and climatic parameters over a spatial surface and methods to assess the goodness-of-fit of the spreading algorithms. Develop algorithms that integrate kriging, co-kriging, and multi-variate kriging into a commercial Unix-based GIS system (i.e., Arc/Info) to facilitate terrain-based mapping.

DESCRIPTION: There exists a need to have the capability to spread terrain and climate information over a map background. This capability would assist the military planner in a) providing more detailed, accurate terrain information about a battlefield and b) examination of levels of climate that would impact fielded materiel, personnel and selected operations at intended deployment locations. Various types of topographic and climatic data suffer from a rather low density of measurement sites and the random nature of the sites themselves. Recent literature has shown that certain surface-based variables are capable of being spread spatially to some degree of exactitude. Such techniques as kriging, cokriging, multivariate kriging, and inferential statistics have been shown to hold promise in being able to generate climate element surfaces with varying degrees of accuracy. The models must be driven by commonly available terrain and climate data - or data derived from this information. Models may be created or borrowed from professional quality geostatistical software (i.e., GeoLib). Integration of geostatistical software with a GIS for the purpose of georeferenced map output is the critical step to be developed.

PHASE I: Examine the current state-of-the-art in spreading techniques. Select a fairly homogeneous geographic/climatic area and evaluate the performance of existing models. Develop empirical preliminary models that focus on the spreading of data (i.e., temperature, precipitation, soils, vegetation, etc.). Assess the impacts of other variables on

model performance (elevation, locational and other environmental). Evaluate the performance of these models as compared to the existing techniques.

PHASE II: Extend the lessons learned in Phase I to fine tune the developed models. Extend the case studies to include more diverse environmental regions (e.g., mountainous areas). Assess model performance with respect to military as well as civilian applications and make recommendations for further research efforts. Integrate the geostatistical model results into a format that is importable and mappable within a commercial GIS such as Arc/Info. Design and develop any necessary graphical user interface (GUI) to facilitate the transition of geostatistical kriging results into the mapping environment and to facilitate the ease of use of the pertinent geostatistical software modules.

POTENTIAL COMMERCIAL MARKET: The ability to spread terrain and climatic information has potential civilian usages. Geostatistically based interpolation modules to be add-ons for commercial vendors of GIS and image processing software would be of high value. There are no multi-variable geo-based interpolation routines of any quality on the market. In regards to temperature, the heating and air conditioning community, building design and construction trades and agriculture all have a keen interest. Precipitation surfaces would aid in the determination of suitable sites/regions for agricultural utilization.

U.S. Army Waterways Experiment Station

A96-119 TITLE: Small-Scale Shock Sensors

CATEGORY: Exploratory Development

OBJECTIVE: To develop small-scale precision airblast and ground shock/motion gages

DESCRIPTION: Small-scale laboratory weapons effects and structural response tests provide critical information to military planners. To properly conduct such experiments very small scale precision pressure and ground shock and motion sensors are needed. To meet the desired objective at the proposed test scale, the instruments are required to be approximately 1 mm in the sensing direction and no more that 5-6 mm wide normal to the sensing direction. The instruments must have a frequency response on the order of 1 MKz, and be able to withstand the shock environments of well over 100,000 g's and peak pressure/stress from 0. 7 MPa (100 psi) to 340 MPa (50,000 psi). Innovative methods will be needed in order to construct rugged sensors of this size and capability.

PHASE I: Design, predict the performance of, construct, and test prototype gages for use in the precision weapons effects tests described above.

PHASE II: Improve design to optimize sensor performance and constructability, and test improved sensors over a broad range of shock environments.

POTENTIAL COMMERCIAL MARKET: Rugged, small-scale blast gages have an extensive market throughout the R&D community that studies shock physics. The market includes DoD and contractor laboratories, academic institutions, and other organizations that conduct R&D in military, aerospace, civil engineering, and other fields.

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A96-120 TITLE: Static Laser Profilometer and Holographic Visualization Tool

CATEGORY: Advanced Development

OBJECTIVE: To develop a system to digitally measure and visualize the topography of surfaces of structures before and after damages. The digital topography of the damaged surface will be in a format for direct comparison with numerical predictions for validations.

DESCRIPTION: Advanced development of an existing technology is needed to provide the capability to digitally map surfaces from distances as short as a meter to as far as a hundred meters. This technology uses a scanning laser device modified to measure static displacements. The resolution required would depend on the scale of the maximum changes in the topography. This capability is not currently available. Development requires a unique system integration of laser measuring technology, data acquisition and computer technology, and holographic projection.

PHASE I: Develop the static displacement measuring capability for an existing scanning laser vibrometer system.

PHASE II: Develop the integration of a three-dimensional holographic projection for displaying digital images of numerical predictions and experimental results of structural damages from blast effects (or any other loading effects).

POTENTIAL COMMERCIAL MARKET: A system capable of measuring topography and roughness of any surface and also providing 3-D visualization will have extensive industrial and commercial applications. For example, such a system could be used for quality control in manufacturing operations. The technology could also be applied to evaluate the condition of concrete structures, roadways, and airfield runways.

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U.S. Army Research Institute

A96-121 TITLE: Dialogue-Based Language Training

CATEGORY: Exploratory Development

OBJECTIVE: To simplify computerized language tutoring through the development of advanced software techniques and to transfer concepts learned in language tutor development to the development of an authorable, dialogue-based military information and procedural tutor.

DESCRIPTION: Current and future, joint and international activities demand improved access to foreign languages, that can be provided on demand by intelligent software in either standalone or distributed, internetted environments. This research will make the existing dialogue capabilities in the Military Language Tutor fully authorable by language instructors by developing an artificial intelligence (AI) knowledge base that can be programmed by individuals with no computer programming expertise. The contractor will improve the language-independent dialogue capability of the Military Language Tutor so that it is capable of dealing with more complex constructions, such as anaphora, and has a larger language generation capability, in additional foreign languages. The contractor will add the ability of instructors to add new nouns to the lexicon and semantics components of the Military Language Tutor. Such additions will not require that the instructors be either computer programmers or computational linguists. This will be done for all proposed foreign languages. The contractor will develop an English language dialogue system capable of supporting military informational and procedural lessons. This will include a full sized, militarily oriented, English computational lexicon plus natural language processing and semantics engines. This military information and procedures dialogue tutor will integrate all the advanced features described above, and be both stand alone and distributed, internetworked in its delivery. The development of a military dialogue-based lesson will provide a demonstration of the authoring capability and an intrinsically useful product for the Army.

PHASE I: In Phase I, the contractor will develop the conceptual approach and the detailed system design of the system which incorporates the elements described above. This will include the interface screen designs for the authorable AI knowledge base and the components of the lexicon and semantics engine that allow the addition of new nouns. The new AI knowledge-based scenario will be defined in detail. The military dialogue-based lesson and its internetted delivery will be defined and outlined.

PHASE II: In Phase II, the contractor will develop the software described above and integrate it within the Military Language Tutor. The contractor will alpha and beta test the resulting software and make required fixes. The contractor will develop and integrate a new knowledge-based scenario and demonstrate its language independence by applying it to all language versions of the Tutor. The contractor will develop a military information and procedures dialogue lesson and demonstrate it.

POTENTIAL COMMERCIAL MARKET: The potential commercial market for a language tutor that can engage students in realistic dialogue such that the dialogue can be altered by instructors, is significant. It is this dialogue capability that defines the real task of language use. As such, being able to practice it is central to learning language. To the extent that such an authorable dialogue component can be added to existing Army language tutors it will greatly enhance their training value and

their cost-effectiveness. The ability to simulate an instructor in one-on-one dialogue has always been the primary goal of computer-based learning. It is this type of teaching that has always been the most effective, but also the most costly. Current advances in natural language processing now make simulating dialogue possible. The potential commercial market for a tutor that can teach through dialogue is very large. When the dialogue of such a tutor is authorable, and the delivery internetworked, the market expands to an even greater extent. The conversion of the military knowledge and procedures tutor to a general or industrial tutor would be relatively easy and of great value.

A96-122 TITLE: Network-Based Training and Feedback to Improve Staff Performance

CATEGORY: Exploratory Development

OBJECTIVE: To provide a network-based training tool, using existing hardware and software technology, which will apply situational awareness and group decision making principles to a digital, distributed work environment. This tool should provide generic staff training to support specific applications for Force XXI.

DESCRIPTION: In the information age, an organization's ability to perform effectively will depend on the ability of the staff to operate in a digital environment. However, few organizations can sustain frequent off-site training to develop such skills. The training tool proposed here should provide on-site staff training for operating in a digital environment. This staff training tool must assume a fully digital, Internet work environment, where most information sources, human or electronic, provide information, including graphics, digitally. The network-based training tool must teach staff members decision rules to avoid information overload by excluding extraneous information, and by filtering and routing necessary information only to appropriate staff members. The infrastructure should be based on recent theory and research in shared mental models (e.g. commander's intent) situational assessment/awareness ("seeing" the situation, anticipating future actions), and group decision making principles. It must incorporate the latest research on cooperative workspaces and techniques in intelligent training to eliminate the need for instructors. The tool should incorporate intelligent, on-demand training within the electronic workspace for information sharing and decision making for staff functions. The product should provide a foundation for building staff skills to operate effectively in a digital environment.

PHASE I: This phase involves the conceptual development of the network-based training tool for distributed digital workspaces. Products include specifying necessary hardware and software and the specific training approaches. Training strategies should teach decision rules for information processing to avoid information overload, techniques to develop shared mental models, situational assessment skills, and group decision making and decision implementation skills. The product should also specify the feedback and intelligent training architecture that will be provided in these areas.

PHASE II: This phase consists of implementing the plans developed in Phase I. It involves obtaining or developing the hardware and software, and specific training packages. The contractor will demonstrate the effectiveness of the training using an appropriate staff.

PHASE III: This phase entails executing and validating the utility of the intelligent training and feedback system for distributed workspaces in a military or civilian setting.

POTENTIAL COMMERCIAL MARKET: Today, rapid staff turnover in both the military and private sectors compounds the need for staff training. A wide range of staff organizations, ranging from emergency medical personnel using voice and graphic data in "telemedicine" to global corporations, use network conferencing for executive decision making and to handle voluminous amounts of digital information. Funding for formal, off-site training has been reduced. Staffs need a readily available way to practice, receive feedback on, and improve staff performance. This potential product fulfills these commercial training needs.

A96-123 TITLE: Effects of Networked, Automated Surveys

CATEGORY: Exploratory Development

OBJECTIVE: To determine the effects on responses and implement improvements for using networked, automated, confidential surveys.

DESCRIPTION: Increasing availability of computers, local area networks and access to the internet have created more opportunities and reduced the costs of survey data collection, and raised new questions about the effectiveness of confidential, automated surveys. However, very little information is available on what effects automation, confidentiality, and digital software

conventions have on the responses of survey respondents. There are many aspects of questionnaire format, confidentiality, and modes of responses which need to be investigated to improve automated survey construction. For example: What are the variables that could be expected to increase or decrease respondents' willingness to respond or their truthfulness, versus paper and pencil surveys? What is the effect of presenting the response scale in various types of format, such as the traditional location under the questions, or in a separate window? What is the effect of not being able to see a full page of the questionnaire or the overall length of the questionnaire? What is the effect of not being able to quickly review the responses to previous questions? In addition, how can analysis, front-end and interface components be embedded in the surveys to provide flexible and individualized interaction? Almost every aspect of survey questionnaire design and actions necessary for completion and analysis needs to be studied in order to assess the kinds and extent of effects that digital automation has on individuals' responses and response patterns.

PHASE I: Identify the aspects of survey questionnaire design, confidentiality, or format development and analysis which need to be (and can be) studied in order to respond to the study objective and improve survey software.

PHASE II: Develop the design and implement it, comparing the responses of digital automation with those obtained with traditional paper-pencil modes of data collection. Recommend procedures which develop confidentiality options and minimize response bias and error for automated surveys. Automate those procedures and embed them in the survey software.

PHASE III: Implement and market the findings and any software products to civilian firms which provide software for preparing survey questionnaires.

POTENTIAL COMMERCIAL MARKET: Knowledge of the effects of digital software architectures on survey responses is important for all military and non-military users of PC automated survey data. Response modes also have potential impacts for other information collection activities, especially for sensitive data.

U.S. Army Space and Strategic Defense Command

A96-124 TITLE: <u>Reduction of Coincidental and Intentional Electromagnetic Interference</u>

CATEGORY: Exploratory Development

OBJECTIVE: Identify, develop, and demonstrate low cost techniques to isolate electronic systems from external radio frequency (RF) interference.

DESCRIPTION: The expanded use of commercial-off-the shelf (COTS) equipment in military systems leads to increased probability that electronics will be operated in RF environments that are more severe than those for which the equipment was designed. We desire to extensively use COTS and still have confidence that it can quickly, cheaply, and easily be modified to meet operability requirements on the battlefield. Proposed RF countermeasures must work in real time and ensure system operability in the presence off friendly and hostile RF emissions. It is desired to be able to mitigate the effects of external wide band noise, nuclear electromagnetic pulse (EMP), non-nuclear EMP which might have a higher frequency content than nuclear EMP pulses and continuous emissions from both friendly systems and hostile jammers/weapons countermeasures should be able to defeat multiple pulses from high power sources. We desire generic solutions for mitigation of RF effects from pulsed and CW sources. Classes of systems for which mitigation techniques are sought include computers, communication equipment, radars, and missile electronics. The RF effects mitigation techniques may be based upon hardware or software techniques or a combination of both.

PHASE I: Analyze, design, and conduct proof of principle demonstrations of the effectiveness of techniques to ensure operability of electronics in the presence of external RF emissions.

PHASE II: Develop operable prototypes and conduct tests to evaluate performance of the protected equipment in the presence of disturbing RF environments. Evaluate the effectiveness and confidence of proposed RF effects mitigation techniques and prepare detailed plans for implementation in a appropriate military and commercial application.

POTENTIAL COMMERCIAL MARKET: There is a very large market within commercial electronics industries to ensure that important electronic systems remain operable in the presence of increasingly severe peacetime RF environments. In addition, protected commercial equipment should not be excessively susceptible to deliberate (terrorist) threats.

A96-125 TITLE: Innovative Decision Aid

CATEGORY: Basic Research

OBJECTIVE: Develop an innovative process that will take data from a wide range of disparate sources as input and recommend a decision to a human.

DESCRIPTION: This is not a new problem. However, the information age and digitization of the battlefield have intensified the need for a solution. Artificial intelligence, neural networks, data fusion, fuzzy logic, and others are players in these area. Using one or more of these is not prohibited, but a new, innovative architecture is sought. The process should prioritize, compress, and fuse the data. Then the process should make a recommended decision based on the inputs and previous experience. The process should be robust. That is, it should be able to make the correct recommendation most of the time even with insufficient or incorrect data. The process need not run on a digital computer for maximum performance. The process should be based on science, but mathematical proof is not required if it works.

PHASE I: Show the feasibility of the process by simulation or other means. While innovative technologies sometimes do not have an available market, another task of Phase I will be able to identify a specific market and/or customer. A specific application (problem and solution) and customer needs should be analyzed.

PHASE II: Implement the process studied in Phase I. Develop the hardware/software package necessary to demonstrate the process. At the end of Phase II, a product capable of being demonstrated (preferably on a PC) to potential customers should be available.

POTENTIAL COMMERCIAL MARKET: Any human faced with making a decision in a limited time based on a large amount of data may be helped by the decision aid. Pilots, power station operators, air defense tactical operations center commanders, military commanders, manufacturing plant managers, and others may be candidates for this product.

A96-126 TITLE: Virtual Parabolic Dish Antenna

CATEGORY: Exploratory Development

OBJECTIVE: Investigate the physics and engineering aspects to consider in designing C, X, and Ku band SATCOM antenna that is "virtual" rather than a parabolic dish.

DESCRIPTION: The design would rely upon mass producible reflective elements that would be located parabolically in a skeletal framework and oriented toward any of three interchangeable feedhorns depending upon the band of interest. Alternatively, the design would rely upon mass producible collecting elements that would be located parabolically in a skeletal framework and need an integrating segment to mix together arriving radio frequency energy in the C, X and Ku bands for recombination into the original transmitted signal. In both cases, the framework would be designed so as not to be susceptible to disturbance from high winds, and to allow precise tracking of the satellite transponder.

PHASE I: Show the feasibility of developing and designing a "virtual" antenna for C, X, and Ku bands.

PHASE II: Design, develop, build and demonstrate one or more prototype "virtual" antennas for C, X, and Ku bands.

POTENTIAL COMMERCIAL MARKET: The satellite communications market is growing rapidly. The "virtual" antenna should have applications in the satellite communications market.

A96-127 TITLE: High Resolution Tracking of Distributed Targets

CATEGORY: Exploratory Development

OBJECTIVE: Identify and explore methods for improving the ability of high resolution radars to maintain track on targets whose scattering centers are distributed over multiple resolution cells.

DESCRIPTION: Typical tracking radars have modes: bandwidths for which multiple scattering points across a target cannot be distinguished. To these radars, targets appear to be point sources which may fluctuate in amplitude. However, high resolution radars frequently have sufficient bandwidth to resolve multiple scattering points of a target. As the multiple scattering

points fluctuate during track, the radar track point may jump between the scattering points. This jumping/wandering of the track point from look-to-look can induce a change in the apparent velocity of the target. Track filters which attempt to follow such false changes in target velocity may be driven off the target and lose track.

PHASE I: Show the feasibility of developing enhanced tracking methods applicable to targets which have range extent exceeding the range resolution of the radar.

PHASE II: Prepare specifications for implementing the new track method(s) in selected high resolution radars. Develop the necessary software/hardware to implement the new approach.

POTENTIAL COMMERCIAL MARKET: The cataloging of satellites and their orbital parameters is an ongoing process of interest to both government agencies and private companies. Many of the satellites are large compared to a radar resolution cell, so the new tracking methods developed will be directly applicable and transferable to these radars.

TOPIC: A96-128 TITLE: High Temperature Materials Testing and Development Using High Energy Lasers

CATEGORY: Basic Research

OBJECTIVE: To create advanced methods for commercial high temperature materials testing using existing DoD high energy laser technologies, thereby reducing the development costs for advanced high temperature materials.

DESCRIPTION: We, at the High Energy Laser Systems Test Facility, propose the creation of a commercial high temperature materials testing industry utilizing existing mature continuous wave HF/DF chemical High Energy Laser (HELs) as well as pulsed C02 HEL technologies. High temperature materials include all materials intended to operate in high temperature environments. Rocket nozzle materials, fusion reactor wall and "diverter " materials, and high angle of attack reentry vehicle materials are three candidate areas of application. Military R&D lasers, available at HELSTF for commercial testing, are large enough Megawatt Class to envision component level failure tests simulating severe thermal environments at substantially reduced testing cost for product developers.

PHASE I: Early efforts should include a study (or review) of existing commercial high temperature materials and how they are tested. An effort to further analyze and identify critical needs of High Energy Laser Systems Test Facility HELSTF) potential high temperature materials research customers will also be required. Finally, a small scale demonstration of laser methodologies for known high temperature materials will be required.

PHASE II: Second Phase efforts will attempt large scale component level demonstrations leading to potentially patentable testing processes.

POTENTIAL COMMERCIAL MARKET: The market for such high temperature materials commercial testing processes while in the early stages of development, appears substantial and durable due to the large variations in potential and products and end product requirements.

A96-129 TITLE: Reentry-Tracking Improvements for the TRADEX Radar

CATEGORY: Exploratory Development

OBJECTIVE: Explore methods of improving the TRADEX track filter to maintain track on reentry objects whose drag profile is either unknown or deviates from priority predictions.

DESCRIPTION: Certain classes of reentry objects observed by the TRADEX radar have drag profiles which deviate significantly from permission estimates. Although TRADEX radar (a coherent signature and metric radar) is capable of tracking well behaved targets during reentry, it can have difficulty maintaining track on targets whose drag profiles are uncertain.

PHASE I: Show the feasibility of developing track algorithms for implementation at the TRADEX radar to allow improved tracking of reentry vehicles which have uncertain drag characteristics. Validate the trackfilter algorithms via simulation.

PHASE II: Prepare specifications of the track algorithms to be implemented in the TRADEX real-time program. Assist TRADEX personnel with the installation of the trackfilter and planning site tests of the installed filter.

POTENTIAL COMMERCIAL MARKET: The improved trackfilter will be readily transferable to radars at other military test ranges preventing loss of track and allowing test data to be collected without expending resources to repeat test. In addition, the filter can be extended to other government and commercial tracking facilities allowing them to maintain track on targets which otherwise might have been lost.

A96-130 TITLE: Data Compression for Post Mission Data Reduction at ALTAIR

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this effort is to design and build a software post mission data compression system for the ALTAIR radar.

DESCRIPTION: The design of the Nyquist Recording System (NRS) at ALTAIR includes a minimum data storage capacity of 4 GBytes. On some high interest missions, this quantity of data is required to be transferred from the ALTAIR field site to CONUS as quickly as possible over the High Speed Data Link (HSDL). The HSDL is a digital SatCom link operating at 1.5 MBps. Transmission of 4 GBytes of data would take over 500 hours at this rate. Compression of the radar data prior to transmission would allow faster data transmission, speedier post mission analysis, and reduced storage requirements.

PHASE I: Investigate the performance of data compression algorithms against test radar data from Near Earth targets. Determine best compression algorithm for radar data.

PHASE II: Design and code post mission software to compress/uncompress data recorded in NRS format. Test with mission data at site.

POTENTIAL COMMERCIAL MARKET: Phase II proposals should also include an assessment of the commercial applications and markets for use of the data compression system with the FAA air traffic control system and harbor and ship traffic radar control systems.

U.S. Army Medical Research and Materiel Command

A96-131 TITLE: Information Systems in Drug Discovery and Development

CATEGORY: Exploratory Development

DESCRIPTION: The Walter Reed Army Institute of Research maintains one of the world's largest chemical inventory and biology databases in support of the USAMRMC's research and development missions. The Division of Experimental Therapeutics is in the process of designing and implementing systems for the storage and retrieval of information developed from 500,000 chemical samples tested in USAMRMC programs. The goal of this topic is to develop an integrated report generator (IRG) which will combine data from the inventory, biology and chemical structure databases and make it available to all of the Command using client/server computing. This will eliminate duplication of effort with its duplication of costs. It will facilitate molecular modeling efforts and lead to the discovery of structure activity relationships in the development of prophylactics and therapeutics.

PHASE I: Create and develop client/server computing for high-speed access to the information systems.

PHASE II: Design, develop and implement systems for the simultaneous retrieval of chemical structures with their associated inventory and biological testing results These systems will be used to develop printed reports or for the direct on-line comparison of chemical structures in two and three dimensions as a function of biological activity.

A96-132 TITLE: Non-Invasive Intracranial Pressure Sensor

CATEGORY: Exploratory Development

OBJECTIVE: To develop a non-invasive sensor capable of reliably (R-second power for correlation with accepted methods must exceed 0.9) determining intracranial pressure directly or indirectly. Such a sensor can be envisioned, eventually, as either a body-worn sensor, or as part of a hand-held, palm-sized sensor suite holding a variety of sensors. Output from the sensor will be in a standard form, suitable for input to standard PC-type computers, or to other, military hardware currently in development,

such as the Trauma Control Module or small, hand-held personal computers such as the Soldier Individual Computer (adapted for medical applications).

DESCRIPTION: This non-invasive intracranial pressure sensor must provide output in 15 seconds or less, and output should be "nominally" in standard units of pressure, such as Torr or mmHg. Together with such other instrumentation as the medical decision algorithm within the Soldier Individual Computer, this sensor should be capable of up-dating itself on a minute-by-minute basis.

PHASE I: Develop realistic proof-of-principle and demonstration, based on state-of-the-art design concepts, scientific literature values, previous models and validated assumptions including descriptions above.

PHASE II: Validate proof-of-principle with experimental data; refine design concepts as necessary. Phase II prototype (suitable for further testing at government laboratories) must be capable of updating data from previous readings, in order to determine whether intervening treatment was effective, or whether spontaneous course of casualty is changing.

POTENTIAL COMMERCIAL MARKET: Because head injury is a leading cause of death and disability in civilian as well as military trauma, and because determination of intracranial pressure is an effective diagnostic tool for assessing head injury, the commercial market is significant. Potentially, this device could be used on every vehicle responding to emergencies and by every paramedic, as well as for triage by qualified medical personnel.

A96-133 TITLE: Field Portable Digital Ophthalmoscope/Fundus Camera

CATEGORY: Exploratory Development

OBJECTIVE: To develop a non-mydriatic ophthalmoscope/fundus camera suitable for user under field conditions that will permit acquisition and storage of digital images and rapid assessment of basic visual function.

DESCRIPTION: Eye injuries constitute approximately 10% of combat casualties. Definitive ophthalmological care is not routinely available far forward in the field medical system. Telemedicine offers the potential to extend the availability of definitive specialty ophthalmic care to lower echelons and thereby reduce morbidity in eye-injured soldiers and civilians. Diagnosis and treatment of ocular injuries depends on careful inspection of the fundus by trained specialists and accurate assessment of visual function. Current fundus cameras are not compact and rugged enough for field use. The development of a smaller, more rugged camera would allow providers at forward medical treatment facilities to image the fundus of injured soldiers or civilians. Acquisition of image in digital form would permit transmission of the fundus image to distant sites where access to specialized care would be available. This would allow the provider on the scene to receive diagnostic and treatment recommendations from experts with detailed, immediate knowledge of the case. Integrating the capability to perform basic visual function tests, such as acuity and Amsler grid measurements, will further improve the diagnostic utility of the system.

PHASE I: Survey existing fundus camera/digital video technology. Conduct feasibility/design trade-off study to specify desired performance characteristics of proposed system.

PHASE II: Produce prototype system; demonstrate the ability of the system to acquire and store images of acceptable quality for diagnostic interpretation.

POTENTIAL COMMERCIAL MARKET: This system will also enhance the ability of civilian providers to diagnose and treat ocular trauma and disease processes such as hypertensive and diabetic retinopathy.

A96-134 TITLE: Expression and Purification of Recombinant Proteins

CATEGORY: Exploratory Development

OBJECTIVE: To improve methods of recombinant protein expression and subsequent purification using "in vitro" or "in vivo" expression systems applied to pathogens of military significance.

DESCRIPTION: Currently, several expression systems are used to express recombinant proteins including viruses, bacteria, fungi, and transgenic plants or large animals. We require improvements in the current expression vector systems or host strains used for recombinant expression of military significant antigens or unit vaccine components. It is important to evaluate the efficiency of subsequent cleavage of fusion peptides/proteins often designed to assist affinity purification of recombinant proteins.

Also important are improved methods of endotoxin removal during the purification process. Recent development in PCR amplification and cloning of immunoglobulin VH regions have identified methods for rapid isolation of complimentarity determining regions (CDRs) encoding high affinity antigen binding sites. In addition, directed mutagenesis can convert low affinity binding sites to high affinity. By incorporating this technology with production of transgenic plants or large animals for expression of these CDRs on conserved framework structures of human immunoglobulins, it should be possible to produce large amounts of functional protective antibodies.

PHASE I: For production of recombinant vaccine components, initial studies can compare amounts of proteins made by different expression systems. Strong consideration should be given to the subsequent ease of purification of endotoxin-free recombinant proteins. For recombinant human antibodies, research should demonstrate the capability of rapid selection of high affinity CDRs that bind and neutralize a pathogen, construct IgA or IgG isotypes using the selected CDR, determine the affinity of the antibody constructs, and select candidates for expression in either transgenic plant crops or transgenic large animals. Specific pathogens of interest include plague, anthrax, botulinum toxin, Staphylococcal enterotoxin B, Venezuelan equine encephalitis virus, dengue virus, and other militarily significant agents.

PHASE II: After selection of an optimal expression systems, increase efforts to achieve purification of recombinant proteins as vaccine candidates or functional protective antibodies. Perform preclinical efficacy trials to support submission of the product to the Food and Drug Administration as an Investigational New Drug.

POTENTIAL COMMERCIAL MARKET: There are universal applications for improved expression systems and purification techniques for recombinant proteins. Sub-unit recombinant vaccines and protective antibodies produced by these methods could be quickly prepared against domestic and tropical diseases endemic worldwide.

A96-135 TITLE: "In Vitro" Exogenous Metabolic Activation System for Use in the Frog Embryo Teratogenesis Assay - Xenopus (FETAX)

CATEGORY: Basic Research

OBJECTIVE: Develop and validate a mammalian-derived "in vitro" exogenous metabolic activation system for use in the Frog Embryo Teratogenesis Assay - Xenopus (FETAX).

DESCRIPTION: There is a need to assess the potential human developmental toxicity of individual chemicals and complex chemical mixtures found in the environment. This information on human health hazard could be used in the risk assessment process. FETAX has been validated as an assay system for the detection of developmental toxicants. In order for the FETAX to be useful in the detection of all potential human developmental toxicants, a mammalian-derived exogenous metabolic activation system must be incorporated into the assay. This system will simulate the metabolic activation which occurs in mammals which results in the activation of xenobiotic chemicals into their more toxic forms.

PHASE I: Develop a mammalian-derived metabolic activation system for incorporation into the FETAX assay system.

PHASE II: Complete development and perform validation of the metabolic activation system.

A96-136 TITLE: Innovative Design and Synthesis of Antiparastic Agents

CATEGORY: Basic Research

DESCRIPTION: Malaria was a significant casualty producer in both World Wars, the wars in Korea and Vietnam, and recently, the deployment to Somalia. The global emergence of drug resistant strains of faliciparum malaria threatens the effectiveness of standard antimalarial drugs available to the military. Thus, a requirement exists for the discovery of new structural classes of drugs effective against multidrug resistant malaria. In the past, the acridine, quinoline, and phenanthrene ring systems have provided platforms for the synthesis of many effective antimalarials, however, cross resistance between these structural types is increasingly common. New approaches to the design of antimalarial agents are required in order to overcome the phenomenon of resistance. Two approaches are possible: rational design, or protein structure-based drug design. Rational design includes the discovery of novel chemical entities structurally unrelated to previously employed antimalarial agents, or the discovery of agents capable of modulating parasite resistance mechanisms. Consideration of the comparative biochemistry of the host and parasite should provide the rational molecular targets for a synthesis program which will culminate in the discovery of safe and effective antimalarial agents. Protein structure-based drug design includes the discovery of new compounds through consideration of the information derived from the 3-D molecular structure of target proteins obtained through x-ray crystallography. This

project envisions the identification, cloning and "in vitro" expression of target proteins followed by isolation of milligram quantities of expressed proteins, purification to homogeneity and production of crystals suitable for x-ray diffraction studies. Determination of 3-dimensional x-ray structure of crystallized protein, design of new drugs and lead compounds based on crystal structure and initiation of "in vitro" assays to evaluate efficacy of those compounds. Rational approaches to the design of resistance modulating substances capable of overcoming parasite multidrug resistance using the above technologies would also be appropriate.

PHASE I: Rational Drug Design: Synthesis and submission of an adequate number of new chemical entities to the Army antimalarial drug evaluation program. This will allow the development of an understanding of the relationship between structure and antimalarial activity for a new class of antimalarial agents or malaria drug resistance modulators. Protein Structure-Based Drug Design: Clone, express, isolate, and purify key target proteins of "Plasmodium falciparum" or other parasites of military import. Obtain crystals suitable for x-ray diffraction studies. Provide crystals or genes to the Army program, if requested.

PHASE II: Rational Drug Design: Scrutiny of the biological activity of candidates submitted for testing will guide the design and synthesis of a second generation of agents with enhanced antimalarial activity. Protein Structure- Based Drug Design: Determine the three dimensional locations of the atoms in the target protein through x-ray crystallography. Use the molecular structure derived from these studies to design molecules complementary to the target protein's active site which will serve as specific inhibitors of the target protein. Provide electronic files of the three dimensional atomic coordinates of the target biological molecule to the Army program, when requested.

A96-137 TITLE: Retinal Drug Delivery System

CATEGORY: Exploratory Development

OBJECTIVE: To develop a system which will permit infusion of sufficient concentrations of therapeutic drugs to the retina for effective treatment of inner eye injuries and diseases

DESCRIPTION: Delivery of drugs to the retina in sufficient quantity to achieve therapeutic results is impossible in most cases. Drugs given as eye drops do not reach the retina in appreciable quantities. The blood retinal barrier prevents penetration of many systemic drugs (given orally or by injection) into the retina. Drugs which do cross this barrier often have to be given in high concentration when administered systemically, which makes their retinal use risky due to increased risk of unacceptable side effects. A system which will ensure drug delivery to the eye will permit treatment of retinal lesions (such as laser induced injuries) more effectively using valuable drugs such as anti-inflammatories and neuoprotectives. Such a system would have wide application in both civilian and military medicine.

PHASE I: Review relevant literature; evaluate design alternatives; design the system; evaluate the relevant pharmacokinetics and pharmacodynamics of relevant drugs.

PHASE II: Construct a prototype system; demonstrate the system in an animal model.

A96-138 TITLE: Development of Pharmacologic Antagonists for Botulinum Toxin

CATEGORY: Exploratory Development

OBJECTIVE: Synthesize effective metalloprotease inhibitors that can interact with and inhibit the active site of three botulinum neurotoxins (BoNTs) serotypes (A, B, and E).

DESCRIPTION: Exposure to BoNTs, the most lethal substances known, leads to flaccid paralysis, respiratory collapse and death. At present, there is no specific therapy for BoNT intoxication; only symptomatic and palliative treatments are available. Recent progress in our understanding of the mechanisms of action of BoNTs offers hope for development of specific BoNT antagonists. A key discovery was the finding that each of the seven BoNTs possesses zinc metalloprotease activity. The BoNTs selectively cleave proteins, termed synaptobrevin (VAMP), syntaxin, and SNAP-25, involved in the docking and fusion of synaptic vesicles.

PHASE I: Initial stages of drug discovery will involve molecular modeling to deduce the three-dimensional conformation of the BoNT serotypes A, B, and E and their protein targets identified above. This should be followed by the synthesis of small peptide-based inhibitors that have functional groups to bind the catalytically-important zinc. The initial

compounds will be evaluated by the U.S. Army Medical Research Institute of Chemical Defense investigators in their validated cell-free systems.

PHASE II: The product developed in Phase I will be tested to prove safety, efficacy, and toxicity. The quantitative structure-activity profile from the Phase I study will be used to obtain a more refined estimate of the active site conformation of the BoNTs and allow for optimal ligand-active site interactions. This information will enable the synthesis of more active metalloprotease inhibitors and provide further refinements of the active site geometry. When peptide-based inhibitors with nanomolar affinities for BoNT are produced, the structural information will be used to design and synthesize non-peptide organic molecules that can be transitioned to therapeutic agents; these would be expected to have better bioavailability and membrane permeability than the initial peptides. Suitable drugs should have a high affinity for the BoNT active site and have low systemic toxicity.

POTENTIAL COMMERCIAL MARKET: The absence of an effective pharmacologic treatment for botulism assures a ready market for a metalloprotease inhibitor to treat this debilitating and potentially fatal intoxication. It will benefit military personnel who face BoNT exposure in the battlefield, civilian populations intoxicated by contaminated food products, and patients who may become intoxicated while receiving BoNT treatment for muscle disorders.

A96-139 TITLE: Development of an Sensitive and Specific Antigen-detection System for "Strongyloides Stercoralis" and Hookworm Infections

CATEGORY: Basic Research

OBJECTIVE: To develop and evaluate a simple, fieldable, inexpensive, sensitive, and specific antigen detection system to identify persons infected with " Strongyloides stercoralis" and hookworm infections.

DESCRIPTION: Soldiers who train and conduct operations in certain parts of the US and in large areas of the tropical world are at risk for infection with soil-transmitted helminths including "Strongyloides stercoralis" and hookworms. Infections have been documented in association with World War II, Vietnam, and more recent tropical deployments. "S. stercoralis" can become a chronic infection with minimal or no symptoms which may pose a problem with hyperinfection and dissemination decades down the line if an infected person becomes immunocompromised as with certain malignancies or therapies. Outside of soldiers it is likely that hundred of thousands (possibly several million) of persons living in the US are chronically infected with "S. stercoralis". Traditional diagnostic technologies such as stool exams, duodenal aspirates, and serologic tests have limitations with respect of efficient mass post-deployment screening or screening prior to the administration of immunocompromising drugs due to cost, practicality, and issues of sensitivity, specificity in general and specificity in the setting of cross-reacting agents such as hookworms. A simple diagnostic method that was sensitive in early infection specific, and logistically acceptable would be a valuable tool for military clinicians and opidemiologists and may have an important civilian application for screening in infectious disease, transplant, and oncologic settings.

PHASE I: Development of the antigen detection assay.

PHASE II: Fielding the assay with a rigorous assessment of sensitivity, specificity, and logistic acceptability.

A96-140 TITLE: Development of a Light Weight Portable System for the Determination of Infection Susceptible Patients and Early Detection of Infection

CATEGORY: Exploratory Development

OBJECTIVE: To measure factors present in injured individuals that predict likelihood of systemic infection or detect its presence early in its course.

DESCRIPTION: There is a critical need to detect and prevent infection in battle casualties as soon as possible after injury. A monitoring system that could be used to predict infection susceptibility after injury and detect it at early stages in battlefield medical facilities would allow detailed observation and facilitate early interdiction of infection in wounded soldiers. Such a system should be portable, field deployable and reliably monitor predictive factors in small quantities of body fluids, providing a timely readout of results to clinicians.

PHASE I: Determine and describe factors which will predict infection susceptibility and allow early detection. Describe necessary analytical tools to measure factors and evaluate results in field medical units.

PHASE II: Build prototype instruments and demonstrate field utility of system in simulated battlefield conditions.

POTENTIAL COMMERCIAL MARKET: The development of a monitoring system that could detect early stages of infection would benefit medical treatment facilities.

A96-141 TITLE: Rapid Confirmation Assays Against Specific Toxins and Infectious Disease Pathogens

CATEGORY: Exploratory Development

OBJECTIVE: Design and test rapid and simple confirmatory diagnostic assays against selected toxins and infectious disease pathogens.

DESCRIPTION: Most diagnostic assays used to confirm the identity of pathogens require expensive and time consuming methods. Even with the advent of polymerase chain reaction, methods may require extensive molecular biology support. Proposed devices or methodologies should reduce the time it takes to make a confirmatory diagnosis to two hours or less. Methods should reduce the need for extensive laboratory support. Proposed assays should reach a level of specificity and sensitivity equal to or exceeding 95%. Assays may be directed against agent-specific antigens, polypeptides, nucleic acids or other biomolecules. Specific pathogens of interest include plague, anthrax, botulinum toxin, Staphylococcal enterotoxin B, Venezuelan equine encephalitis virus, dengue virus, and other military significant agents.

PHASE I: Demonstrate feasibility of device or methodology with pathogens of military significance. Demonstrate minimum levels of sensitivity and specificity (95%) using laboratory-derived specimens or equivalent.

PHASE II: Complete field evaluation of device or assay. Provide sufficient data to support transitioning to advanced development.

POTENTIAL COMMERCIAL MARKET: The developed assay can be adapted and commercialized for identification of any disease agent.

A96-142 TITLE: Rapid Detection of Arthropod-borne Pathogens in Mosquitoes

CATEGORY: Exploratory Development

OBJECTIVE: Adapt the new "wicking dip-stick" detection technology to develop a one-step, "field-usable" assay capable of detecting arthropod-borne pathogens in mosquitoes.

DESCRIPTION: Identification of arthropod-borne pathogens in mosquitoes is normally accomplished by ELISA, a multi-component (4-6 hr) assay requiring specialized equipment, refrigeration/freezing of reagents, and highly trained personnel. However, arthropod-borne diseases typically threaten U.S. troops deployed to developing countries where access to such facilities and equipment is unavailable. Adapting the new generation of rapid (<15 min), stable (ambient storage), one step wicking dip stick technology to the detection of arthropod- borne pathogens in mosquitoes will permit it's use by far forward personnel in any environment. Timely identification of the arthropod-borne disease threat will insure increased compliance with personnel protective recommendations and/or will insure increased compliance with personnel protective recommendations and/or selective vector control efforts. These assays would be of immense benefit to both the Department of Defense (DoD) and to various civilian health agencies throughout the world. Malaria and dengue affect the health of hundreds of millions of civilians throughout the developing world. These diseases also pose a significant threat to U.S. forces deployed overseas, a fact borne out by our recent experiences in Somalia and Haiti. Development of assays for the detection of the pathogens causing these diseases are therefore an extremely high priority for the DoD.

PHASE I: Adapt rapid (<15 min), one step, stable (ambient storage) dip-stick wicking technology to the identification of malaria and dengue-infected mosquitoes. Given a panel of dengue- and malaria-specific polyclonal/monoclonal antibodies and a supply of positive control, i) select the most appropriate antibodies for incorporation into a malaria assay and a dengue assay that meet the criteria listed above, ii) develop a prototype dengue assay capable of detecting 104 plaque-forming units of dengue virus in a pool of 25 mosquitoes, iii) develop a prototype malaria assay capable of detecting 100 sporozoites in a pool of 25 mosquitoes, and iv) produce 1000 dengue assays and 1000 malaria assays to allow for initial laboratory/field validation of assay.

PHASE II: Production and testing of a consistent product (10,000 units of each assay). A direct comparison with "gold-standard" assays will be made to ensure sensitivity of the assay, as well as extensive tests for cross-reactivity and interferents. If the assays meet all requirements, adapt this method to develop (i) a single assay capable of detecting 5 species/polymorphs of human malaria sporozoites in a single assay, and (ii) a single assay capable of detecting flaviviruses, alphaviruses, and phleboviruses. Again, the Army would supply the species-specific monoclonal/polyclonal antibodies required for assay development.

POTENTIAL COMMERCIAL MARKET: The results of this work would have application wherever rapid, inexpensive assessment of mosquitoes for arthropod-borne pathogens was required. This includes extensive application in the military, civilian government, and private health sectors. Use includes locations throughout most of the developing world. Various local (i.e., mosquito-control districts), national (i.e., Ministries of Health, the Centers for Disease Control and Prevention), and international (i.e., the Pan American Health Organization or the World Health Organization) health-care organizations have expressed interest in such field-usable assays.

A96-143 TITLE: Development of Reactive Topical Skin Protectants Against Sulfur Mustard and Nerve Agents

CATEGORY: Exploratory Development

OBJECTIVE: The identification, synthesis, and application of reactive materials capable of neutralizing sulfur mustard and nerve agents (GA, BG, BD, and VX).

DESCRIPTION: Materials must be developed to neutralize sulfur mustard or nerve agents (GA, BG, BD, and VX) that contact the skin. The neutralizing materials should be incorporated into a base cream, containing a mixture of perfluorinated polyether oil and teflon particulates as thickener, for application to the skin as a protectant from cutaneous exposure to these agents. The incorporated materials must enhance the barrier effect by chemically neutralizing or catalyzing the noxious agents, so that in case of barrier breakdown the agents are no longer toxic. The material should have reasonable cost, be safe and nonirritating, chemically stable, and demonstrate rapid kinetics.

PHASE I: Conceptualization and synthesis of prototype reactive topical skin protectant materials capable of neutralizing sulfur mustard or nerve agents (GA, BG, BD, and VX). Incorporating the neutralizing material(s) in a base cream. Reactivity, stability, cost, and skin toxicity must be considered. Efficacy testing will be conducted by the U.S. Army Medical Research Institute of Chemical Defense.

PHASE II: Improve and refine the prototype reactive topical skin protectant into a final product.

POTENTIAL COMMERCIAL MARKET: This research would benefit industries where employees are exposed to toxic materials (e.g., chemical plants, pesticides, and herbicides). Police would benefit from protection against tear gas and other riot control agents. The general public would benefit from protection against environmental irritants such as poison ivy.

A96-144 TITLE: Test System to Detect Enterically-Transmitted RNA Virus Pathogens

CATEGORY: Exploratory Development

OBJECTIVE: Detect the following virus pathogens at concentrations down to 10- third power particles per mL of body fluid (e.g. serum) to 10-fourth power per mL of environmental water: hepatitis E virus, human caliciviruses including Norwalk virus and Snow Mountain virus, hepatitis A virus, poliovirus types 1-3, other enteroviruses, human rotaviruses.

DESCRIPTION: Technology is emerging to rapidly detect rare RNA molecules by hybridization; promising approaches that combine rapidity with sensitivity are those that use solid state electronics to detect hybridization events. Because oligonucleotide probes can be designed to specifically detect the above enterically-transmitted virus pathogens, a field assay system comprised of a sample-concentrating unit (for environmental water samples) and a detector unit could be designed. Such a system could be used for rapid detection of virus pathogens in clinical specimens.

PHASE I: Develop a prototype detector unit capable of detecting one or more types of RNA virus genomes to a practically useful level of sensitivity. Poliovirus and hepatitis A virus RNAs are the suggested initial target molecules

PHASE II: Expand the detector's capability to an array of hybridization probes; lower the detection threshold; establish a sample concentrating procedure; construct a prototype instrument for field testing; use the instrument in field tests validated with more conventional virus detection assays.

POTENTIAL COMMERCIAL MARKET: The system could also be used to detect viruses in environmental water to supplement conventional testing for bacterial pathogens; the rationale for virus testing would be to identify sources of virus contamination, to monitor for failure of purification procedures, to indicate environmental risk, to quality-assess food or beverages produced at scale, etc. This technology is very likely to have multiple commercial applications.

Topics Addressing U.S. Army Operating and Support Cost Reduction (OSCR) Initiatives

A96-145 TITLE: Liquid Molded Composite Armor Smart Structures Using Embedded Sensors

CATEGORY: Exploratory Development

OBJECTIVE: Develop an in-situ sensor system for in-process and in-service process, health and dynamic response monitoring of monocoque or hybrid liquid molded composite armor structural parts.

DESCRIPTION: Composites offer lightweight alternatives for armor. The most effective means of manufacturing composite armor is by using liquid molding processes; however, processing and maintenance of thick-section composites requires unique sensor systems. Smart composite structures often contain embedded current-carrying leads or optic fibers used as sensors to determine in-process and/or in-service processing parameters and/or loading responses such as deflections, local strains, vibrations, etc. Many of these structures are manufactured using liquid molding techniques such as resin transfer molding (RTM) and Seeman's composites resin infusion molding process (SCRIMP). In-situ sensing systems may be used to intelligently control the process making production more economical and enabling the production of more complicated parts by a traditionally economical process. These same or other sensors could be used throughout the service of the manufactured part as smart structure material sensors in a state or dynamic mode for in-service damage detection or for active control of, for example, vibrational responses.

PHASE I: Demonstrate for a liquid molding composite armor manufacturing process a sensor or complementary multi-sensor system technology for in-process and in- service process, health, or dynamic response monitoring. Develop and demonstrate compatible sensor acquisition hardware capable of sensing critical or useful in-process and in-service process, health or dynamic response phenomena of a liquid molded part.

PHASE II: Demonstrate the use of in-situ smart sensors or a complementary multi- sensor system through the controlled liquid molding of a composite armor demonstration part. The processing would be intelligently controlled using the sensor-obtained flow/ cure information. Demonstrate subsequent in-service damage detection or control of an appropriate mechanical response of the same part using the in-situ process sensors as smart material sensors and develop/ utilize/ demonstrate an appropriate in-service control system to monitor and correct detrimental mechanical response phenomena.

POTENTIAL COMMERCIAL MARKET: A complementary sensor system providing both in- situ process monitoring and in-service health and response monitoring would have excellent market potential.

OPERATING AND SUPPORT COST REDUCTION: A complementary sensor system providing both in-situ process monitoring and in-service health and response monitoring would offer the government and the commercial marketplace a high potential for vast cost savings. This concept not only offers a real-time quality check on the part/component as it is being manufactured, thereby eliminating the cost of low quality inferior output, but also provides a means to monitor the part/component throughout its lifecycle. Its this lifecycle information that can provide valuable information to the user as to the need or lack of need to replace a particular unit. Early replacement meaning spending dollars unnecessarily to replace a unit that is still in fine working order, or even worse would be the potential cost to NOT replace a unit that has started to fatigue and fails. The embedded sensors will allow us to have the data to make the best, most cost effective and appropriate decisions.

A96-146 TITLE: High Energy Batteries for the Individual Soldier

CATEGORY: Exploratory Development

OBJECTIVE: To provide new/improved primary and rechargeable battery chemistries to power Army portable electronic and electrical equipment.

DESCRIPTION: The Army must up date its battery technology to keep pace with the increasing power demands of emerging portable electronic and electrical equipment. For most applications, the "dual use"/ low cost requirement shares a high priority with the performance requirement. For special applications, highest performance (without sacrifice of user safety) is given the highest priority. The Army's present baseline primary battery is Li/SO2, which provides approximately 160 Wh/kg and 40 W/kg of energy and power density, respectively using present packaging techniques. While the latter chemistry has much merit (good low temperature operation and excellent storability) it is not "dual use ", still presents some concerns over user safety, and does not posses the higher power and energy densities which are now desired. Conventionally-packaged Li/ MnO2 (liquid organic electrolyte, steel cell cases) batteries are being considered as possible successors to Li/SO2. Such batteries would be "dual use", and provide approximately the same room temperature performance as their predecessors, but (as presently formulated) would have restrictions on low temperature operation. Finally, Li/MnO2 packaged in soft plastic cases could provide superior room temperature performance, but presents potential safety concerns. It is anticipated that the Army's baseline rechargeable communications battery will soon comprise a liquid electrolyte "Li-Ion" chemistry. Such batteries will be "dual use" and provide upwards of 110 Wh/kg and 40 W/kg of energy and power density respectively. Low temperature performance limitations, and user safety are still areas of concern. Even higher performance levels are now being sought. Solutions which may be offered to the problem mentioned above may include, but need not be limited to: 1) Improved anodes - Li host alloys (including improved carbons) for primary and rechargeable batteries which will impart greater safety with little loss energy density, power density. 2) Improved cathodes - Li-insertion compounds with greater Li capacity, higher Li diffusivity, better cyclability, lower cost than presently available materials for Li-Ion cells. Other higher energy positive plate materials for primary or rechargeable Li batteries. 3) New/ Improved liquid or gel electrolytes - To enhance low temperature performance, storageability, power density and safety (e.g., through low flammability) of Li batteries. Liquid or gel electrolytes with very low vapor pressures and acceptable conductivity could enable safe packaging in soft lightweight cell cases. 4) Other novel cell components - improved battery separators and additives to enhance performance and/or safety.

PHASE I: Phase I should result in the identification/ synthesis of one or more materials for improved Li or Li-Ion batteries. Materials shall be sufficiently characterized (including prototype laboratory cells if feasible) to demonstrate potential usefulness in improved batteries.

PHASE II: Development and characterization of materials and components are to be completed. Prototype cells are to be developed and demonstrated.

POTENTIAL COMMERCIAL MARKET: Improved high energy batteries are being avidly sought for lap top computers, cellular phones, camcorders and many other electronic and electric equipment. Rechargeable battery chemistries may be useful for commercial transportation vehicles.

OPERATING AND SUPPORT COST REDUCTION: The Army must up-date its battery technology to keep pace with the increasing power demands of emerging portable electronic and electrical equipment. Only through projects such as this one can the Army, DoD and the private sector attack the problem of ever increasing power needs via technology that will produce lighter, smaller, longer lasting, safer, cheaper battery technologies. This type of work in tandem with other ARL projects, such as the power remaining indicator, will lead to better and less expensive fuel cells and reduce the logistics nightmare of always having enough "spares" on hand. This technology could also help lead the U.S. in the practical realization of the national goal of the "Electric Car".

A96-147 TITLE: Advanced Turbomachinery and Mechanical Components for Small Gas Turbine Engines for Air and Ground Vehicles

CATEGORY: Exploratory Development

OBJECTIVE: Develop advanced turbomachinery and mechanical components which lessen the performance penalties inherent in small gas turbine engines.

DESCRIPTION: Gas turbine engines of interest to the Army fall into the small size class, generally having less than 10 lb mass air flow per second through the engine. The small physical size of the turbomachinery and mechanical components forces certain restrictions on these engines in terms of allowable configurations, operating parameters, efficiency, operability, size and weight. As an example, most small gas turbine engines use centrifugal compressors instead of all axial stages to overcome the efficiency penalties associated with very small axial blading. Bearings and dampers become disproportionately large and heavy as engine size is reduced. Innovative turbomachinery and mechanical component configurations are sought which will lessen the performance penalties associated with geometric constraints inherent in small gas turbine engines. Of particular interest are: 1) compact and efficient diffusers for centrifugal compressors, 2) compressor configurations with wide flow range capability, 3) the application of MEMS (Micro Electrical Mechanical Systems) technology to turbomachinery components, 4) lubeless bearings, 5) compact seals (both air-air and bearing compartment, and 6) compact dampers.

PHASE I: Develop understanding of the physical phenomena underlying the proposed concept and show concept viability by performing preliminary analytical and/or experimental investigations. Estimate the potential benefits to be gained from the application of the concept and plan a Phase II demonstration.

PHASE II: Develop and demonstrate the viability of the proposed concept via a " bread board" demonstration. The demonstration test conditions do not have to duplicate actual engine operating parameters, but must be sufficient to incorporate all relevant physical phenomena.

POTENTIAL COMMERCIAL MARKET: Any concept which can significantly improve the performance of small turbomachinery or mechanical components has a virtually unlimited potential commercial market, such as: main propulsion engines, APUs (Auxiliary Power Units), turbochargers, and natural gas compressors.

OPERATING AND SUPPORT COST REDUCTION: The Army has a considerable number of air and ground vehicles, that use gas turbine equipment. This topic calls for technology that can provide advances in turbomachinery and mechanical components that will make these gas turbines more efficient and more reliable. The cost savings over the lifetime of the engines is readily measurable in both their use and maintenance support; an improved engine provides for better and more reliable use while requiring less logistics support, spare parts, down time and service.

A96-148 TITLE: Point Sensor for Airborne Biological Particles

CATEGORY: Exploratory Development

OBJECTIVE: Design, construct and demonstrate a prototype instrument for real-time detection (based on intrinsic fluorescence) and rapid identification of airborne biological particles.

DESCRIPTION: Rapid methods for detecting and identifying airborne biological particles would be useful for a variety of applications, for example, in detecting and controlling the spread of disease of humans, animals, and plants. Real-time detection, as is attainable with light-scattering and fluorescence methods, should prove useful as an indicator of the presence of biowarfare agents. Unlike many non-biological atmospheric aerosols, biological cells contain fluorescent molecules (e.g., amino acids, nicotinamide adenine nucleotides, and flavins). The fluorescence from these molecules is useful in the development of laser based methods for detecting airborne biological particles and for distinguishing them from non-biological particles. Rapid identification of bioaerosols requires reaction of the suspect particles with probes (e.g., antibodies) specific for biomolecules of interest. The development of a prototype particle counter and identifier that uses the intrinsic fluorescence of biological materials for real-time detection and specific probes for rapid identification is the goal of this task.

PHASE I: Perform a systematic study of the issues that affect the feasibility of detection, and possible discrimination, of weakly-fluorescent bioparticles using laser-exited intrinsic fluorescence, and/or absorption spectra. Design a fieldable prototype fluorescence particle counter that measures the fluorescence and elastic scattering of individual airborne particles as they are drawn through the instrument. Determine laser sources and detectors that provide optimum discrimination between biological and non-biological aerosols.

PHASE II: Based on the findings in Phase I, construct a man-portable, lightweight, battery-powered real-time biodetector and rapid identifier that can be deployed for remote, stand alone, monitoring of biological aerosols.

POTENTIAL COMMERCIAL MARKET: Airborne biological particles are important causes of disease of humans (e.g., tuberculosis, influenza), animals, agricultural crops, and forest trees (e.g., white pine blister rust). Bacteria are being disseminated in the air for the control of insect pests in large areas. Allergies caused by airborne bacterial particles are of

major importance. Methods to rapidly detect and identify airborne biological particles could have major applications in medicine, occupational safety, and environmental protection, in addition to their applications to national defense.

OPERATING AND SUPPORT COST REDUCTION: Methods to rapidly detect and accurately identify airborne biological particles could have major applications in medicine, occupational safety, and environmental protection, in addition to their applications to national defense. The advancement of this type of technology has the potential to go much farther than only saving a few dollars, this technology has the potential to prevent personnel injury and save lives. The dual use applications are obvious, with equally strong arguments on both the Defense and commercial sides. From the threat of biological elements on the battlefield to the identification of a particular allergy causing particle in humans and/or animals to a disease strain attacking plants or crops the cost reduction potential is enormous.

A96-149 TITLE: Detector/ Amplifier/ Mixer Array for a Low Cost Imaging Ladar

CATEGORY: Exploratory Development

OBJECTIVE: This program investigates the feasibility of developing 1 x N detector/amplifier/mixer arrays for a low cost high resolution imaging laser radar.

DESCRIPTION: The Army Research Laboratory (ARL) Sensors Directorate is researching low cost, high range resolution laser radar for battlefield applications such as submunition target acquisition, robotics, fuzing, armor protection systems and low cost remote sensors for smart mines. The motivation is to exploit the very high angular and range resolution of laser radar to obtain 3-D images of targets that can be capably processed by automatic target recognizers expected in these new weapons. To form imagery with laser radar without some mechanical scanning device will require the development of detector/amplifier/mixer arrays. This program begins the process of developing such arrays.

PHASE I: The ARL Sensors Directorate is currently investigating, with excellent success, a unique high range resolution laser radar architecture based on FM radar ranging principles. This ladar architecture is discussed in SPIE (Vol. 2472, Pages 118-129) and requires a detector/amplifier/mixer chain as part of the processing to form range-gates. For current laser radar system applications, the detector/amplifier/mixer chain requires a bandwidth extending from 100 MHz to 1500 MHz, a detector gain of 70, and a low noise amplifier with a gain of 40 dB. The laser operates at 850 nm; however designs that operate in the eye-safe bands can also be considered. For Phase I of this program, the contractor shall perform a study to determine the feasibility of building 1 x N (N=20-30) arrays of detector/amplifier/mixer chains. This study will address a variety of issues including obtainable amplifier gain, noise, detector cross coupling, reliability, size and cost.

PHASE II: Phase II of this program will lead to the construction of a 1 x N detector/amplifier/mixer array, based on the recommendations of the Phase I work. Sample arrays will be constructed by the contractor and then inserted into ARL imaging ladar breadboard for an evaluation of performance.

POTENTIAL COMMERCIAL MARKET: The detector/amplifier/mixer array can be used in any commercial application of laser radar where high resolution 3-D imaging is desirable. Such applications include first-rate collision avoidance systems for automobiles and other vehicles, smart highway applications such as vehicle classification for autonomously determining tools or highway use, mapping, and surveying.

OPERATING AND SUPPORT COST REDUCTION: The early stage development of these LADAR (Laser Radar) components will lead to huge operating and support cost reductions. Once developed and incorporated into next generation "smart weapons", this technology will provide the DoD with a highly accurate and lethal arsenal. Study after study and all advance theory has said that due to the effectiveness of this advanced arsenal, DoD will no longer need vast storehouses of rounds and the logistical nightmare of keeping the forward troops supplied with munitions; the one-target-one-smart weapon capability will supersede this necessity. We will no longer need to fill the belly of hundreds of B-52s and drop mission after mission of bombs, as in WWII Japan or Viet Nam; we will instead be able to use considerably less sorties with highly accurate very powerful weaponry to accomplish the same tasks. It is estimated that LADAR type smart weapons could and will shrink the DoD arsenal by 100 to 1.

A96-150 TITLE: High-Mobility Scout Ground Vehicle

CATEGORY: Exploratory Development

OBJECTIVE: The primary objective is to foster the development of a ground vehicle having independently-controlled active suspension and independent electrically or hydraulically driven wheels. Application of this technology includes both military and civilian vehicles where high mobility is imperative. This class of vehicle would be ideal for reconnaissance and where high speed cross country operation is desired.

DESCRIPTION: It is envisioned that a test bed vehicle could be developed around a combined common roadarm suspension and a motor drive (electric or hydraulic) assembly. Directional control of the vehicle would be via differential power to each wheel. Ground clearance could be varied by independently controlling the vertical position of each roadarm. A conventional disk braking system could be integrated into each electric motor. Power will be provided by either a conventional generator or a hybrid generator and a battery system for an electrically powered vehicle. A conventional hydraulic pump system will provide power to vehicles having hydraulic motors. A conventional hydraulic pump and accumulator or a regenerative system will provide hydraulic fluid to each road arm suspension unit. Vehicle speed, direction and suspension response will be controlled by a fuzzy logic controller. A joy stick like device will be used to input speed and direction control.

PHASE I: Develop an integrated hydraulic suspension roadarm and motor unit suitable for use on a 3000 pound scout vehicle that will produce: a smooth ride at 50 MPH over rough terrain, 30 MPH speed up a 25 degree incline and achieve in excess of 80 MPH across level hard surface roads. The vehicle shall have a side slope in excess of 60 degrees. Deliver unit to the Government for their evaluation using fuzzy logic controller.

PHASE II: Develop a ground vehicle test bed using four hydraulic suspension and motor units developed in Phase I. Commercially available engine, generator and hydraulic pumps would be integrated into the test bed. Integrate the Government developed fuzzy logic controller into the test bed. Test bed vehicle will be delivered to the Government, for their evaluation/enhancement.

POTENTIAL COMMERCIAL MARKET: The Army envisions the future need for a high mobility scout vehicle. The technology developed through this test bed will be instrumental in the development of this future vehicle. This class of vehicle will also have a significant potential as a civilian off-road vehicle.

OPERATING AND SUPPORT COST REDUCTION: OSCR initiatives are exactly why topics like this one are submitted. The proposed SBIR project calls for the development of a "test bed" scout vehicle. This vehicle is not suppose to challenge Detroit or Japan for production vehicles, but what it will do is challenge the standard mind-set on the technologies available and currently in use versus new thinking and possible breakthroughs. Each aspect of this proposed vehicle offers the potential for a better/less expensive vehicle/component. As a 6.1 project this scout vehicle work will attack standard thinking about vehicle propulsion and suspension systems and introduce fuzzy logic control technologies, any or all of which has the potential to provide huge future cost savings while at the same time creating new state-of-the-art vehicle components and concepts.

A96-151 TITLE: Advanced Technology Concepts and Components for Rotorcraft Drive Systems

CATEGORY: Exploratory Development

OBJECTIVE: Develop advanced drive system concepts and components which lessen weight and source noise, and extend reliability beyond current rotorcraft drives.

DESCRIPTION: Power transmission devices are necessary in current Army rotorcraft to transmit the power produced by turboshaft engines to the main and tail rotors. These transmissions are usually comprised of several stages, or modules consisting of: clutches, shafting, gearing, bearings, and other mechanical components. The weight of the transmission system is a significant portion of the vehicle empty weight. In addition, transmission source noise is propagated through the vehicle structure and can reach the pilot with significant magnitude to produce hearing loss over time. Mechanical drives also are responsible for a sizeable portion of the unscheduled maintenance actions required by Army rotorcraft. Novel, light weight, low noise, reliable drive system concepts are sought which will reduce the weight and noise penalties inherent in rotorcraft drive systems and increase their reliability, hence increasing mission capability. Of particular interest are unique arrangements of mechanical components, hybrid or non-metallic components, and non-traditional power transfer methods such as light weight, high power electric generator and motor combinations.

PHASE I: Show concept viability through analytical understanding of the underlying physical phenomena. Perform preliminary performance and sizing studies. As appropriate, conduct proof-of-principle experimental investigations. Plan a Phase II demonstration.

PHASE II: Develop and experimentally demonstrate the proposed concept through a range of operating parameters sufficient to incorporate all relevant physical phenomena.

POTENTIAL COMMERCIAL MARKET: Light weight, quiet and reliable transmissions have great potential commercial application. Reduce weight translates into increased payload and therefore increased revenue. Reduced noise gives greater passenger and pilot comfort, along with community acceptance, or it lessons the need for noise absorption material, which again translates into increased payload and revenue. Increased reliability results in lower operating and support costs.

OPERATING AND SUPPORT COST REDUCTION: Light weight, quiet and reliable transmissions have great potential commercial application. Reduced weight translates into increased payload and therefore increased revenue. Reduced noise gives greater passenger and pilot comfort, along with community acceptance, or it lessens the need for noise absorption material, which again translates into increased payload. Increased reliability results in lower operating and support costs.

A96-152 TITLE: Low Cost Photonic/Electronic Device Integration and Packaging

CATEGORY: Exploratory Development

OBJECTIVE: Develop versatile, low cost, packaging for next generation millimeter -wave (mmw), digital, analog, and opto-electronic integrated components.

DESCRIPTION: Next generation high frequency electronic circuits will include multi-function chips packaged to increase functionality of the module and to decrease overall system bulk and cost. However, low cost producible packaging is not yet available to integrate digital, photonic, microwave, and millimeter wave components together in the same hermetic package. What is required is a reconfigurable, low cost package and packaging scheme that can be used for digital, Optical Electronic Integrated Circuits (OEIC), and Microwave-Millimeter Wave Integrated Circuits (MMIC) components. A standard package would thus be used for all frequencies and technologies, enabling lower cost.

PHASE I: Investigate new and innovative materials, packaging technologies, and package designs for digital, MMIC, and OEIC components to operate to MMW frequencies, and to include optical and MMW interconnects. Packages must be hermetic, low cost, and have the capabilities for optical interfaces from optical fibers into either dielectric or semiconductor optical waveguides. Packages must also have low loss MMW interconnections to antenna and transmission lines and have low loss transmission lines inside the package. Shielding of components must also be considered to eliminate cross talk. Materials to enhance thermal conductivity, control Coefficient of Thermal Expansion (CTE) mismatches, and innovative solutions to electrical interconnects to chips are also sought.

PHASE II: Phase II of the program will consist of the fabrication of the novel configurable package. The configurable package will have to demonstrate its versatility and configurably by utilizing digital, OEIC and MMW technologies and functions, producability at low cost, and hermeticity. A final demonstration will be made by packaging a DoD system module and undertaking system and mil spec testing. Perform a technology transfer to industry and the Physical Sciences Directorate of the Army Research Laboratory.

POTENTIAL COMMERCIAL MARKET: The development of a low loss, low cost, high production configurable package with the capabilities for both optical interconnects and high frequency electrical interconnects for transmission lines and antennas has an enormous commercial impact in the areas of communications such as cellular telephone, satellite, and optical communications, high definition television (HDTV), microwave cable TV, collision avoidance systems for next generation automobiles, and in high speed computers and data links.

OPERATING AND SUPPORT COST REDUCTION: Lower cost and higher quality are a goal of this SBIR project. Next generation high frequency electronic circuits will include multi-function chips packaged to increase functionality of the module and to decrease overall system bulk and cost. However, low cost producible packaging is not yet available to integrate digital, photonic, microwave, and millimeter wave components together in the same hermetic package. What is required is a reconfigurable, low cost package and packaging scheme that can be used for digital, Optical Electronic Integrated Circuits (OEIC), and Microwave/Millimeter Wave Integrated Circuits (MMIC) components. A standard package would thus be used for all frequencies and technologies, enabling lower costs.

A96-153 TITLE: Phytoremediation: Use of Plants in Removal of Heavy Metal Contamination from the Environment

CATEGORY: Basic Research

OBJECTIVE: To develop suitable plant lines that hyperaccumulate and possibly metabolize heavy metals for use in bioremediation.

DESCRIPTION: Heavy metal soil contamination is a significant problem at many military and civilian sites, where lead, cadmium, chromium, copper, and mercury levels present serious environmental and health hazards. The most widely used method of dealing with tainted soils is excavation and reburial - a high cost procedure that is practical only for very small areas. Phytoremediation, or the use of plants to clean up soil, has technical and economic advantages over current methods for removing heavy metals, with, in some cases, the added benefit of being able to concentrate and harvest metals for reuse. Burying contaminated plants is both easier and cheaper than removing contaminated soil because they have far less mass. In cases of contamination with more valuable metals, like copper and nickel, plants can even be burned, leaving behind a residue from which metals can be recovered. Finally, plants can be engineered to convert some heavy metals to inert forms. Research is needed to identify and characterize novel genes and biochemical pathways involved in and/or transforming of suitable plants to hyperaccumulate heavy metals is also required. It is expected that this technology will generate a cost-effective means of removing heavy metals for both DoD and civilian applications.

PHASE I: Identification and characterization of useful genes or biochemical pathways in plants or other organisms that can be used in the phytoremediation of heavy metals; engineering and/or transforming suitable plant species to exhibit the ability to take up and/or detoxify heavy metals.

PHASE II: Development and optimization of transgenic or engineered plant lines that hyperaccumulate heavy metals and transfer, if necessary, of these abilities to crops that are non-edible, easily grown, and easily harvested.

POTENTIAL COMMERCIAL MARKET: This technology can be directly applied to the large and growing number of military and civilian sites in need of heavy metal removal as an economically and environmentally sound alternative to conventional cleanup strategies.

OPERATING AND SUPPORT COST REDUCTION: The topic directly supports the OSCR goal of remediating the environment.

A96-154 TITLE: Remediation of Metal-Contaminated Soil Using Advanced Polymeric Methods

CATEGORY: Basic Research

OBJECTIVE: Develop a polymer and methodology that can remove and recover heavy metals from soil.

DESCRIPTION: The U.S. Army is vigorously working to develop new and more efficient means for environmental remediation. One of the areas of current exploration is the removal of heavy metals such as cadmium, chromium, and lead from soil. Soil contamination is a result of a number of Army-specific processes which include propellant manufacturing, plating, rinse water run-off from contaminated materiel, and the use and testing of munitions.

This solicitation seeks the development and demonstration of a water-soluble polymer that can interact with heavy metals thus removing them from soil. This could be accomplished by a number of means including encapsulation, adsorption, and chemical reaction. The polymer or process must designed such that separation from soil is easily accomplished. It is expected that the metals could be recovered from the polymer and that the polymer could be re-used or easily re- activated. The polymer and associated processing should be environmentally friendly.

PHASE I: Demonstrate proof of concept for a water-soluble polymer that can interact with heavy metals and remove them from soil and subsequently release the metals for recovery.

PHASE II: Demonstrate that the polymer and process can be scaled up for commercial applications.

POTENTIAL COMMERCIAL MARKET: Environmental restoration is not only a key concern of the Army but also the private sector. A new more efficient means for removing and recovering metals from soil is highly relevant to a host of manufacturing processes and remediation efforts in the private sector.

OPERATING AND SUPPORT COST REDUCTION: The topic directly supports the OSCR goal of remediating the environment.

A96-155 TITLE: Honeycomb Structural Sealant

CATEGORY: Exploratory Development

OBJECTIVE: The principle objective of this effort is to develop and demonstrate a sealant for honeycomb composite structures, such as rotor blades, floor panels, and fuselage skins, that both excludes water and prevents water entrapment. The impact to component life cycles shall be investigated to estimate savings to maintenance costs and time.

DESCRIPTION: Water leakage and entrapment into helicopter honeycomb composite structures is a common problem. For rotor blades, the water leakage and entrapment results in corrosion and decreased rotor blade life for a multitude of rotary wing aircraft. A build-up of water in the rotor blades prevents adequate aircraft rotor track and balance, resulting in increased maintenance from vibration problems. Water entrapment in floor panels and fuselage skins adds weight to the aircraft decreasing mission capability and increasing maintenance due to water damage. It is desired to investigate new or improved technologies in polymer coatings that will prevent water leakage and entrapment. The coating must be durable yet flexible enough to withstand the flexure of components such as rotor blades in flight.

PHASE I: Identify and evaluate new coating and application technologies for reducing water leakage and entrapment. The coating must be technologically feasible and prove economical. Test effectiveness of the coating on coupons made from scrap honeycomb components.

PHASE II: Test and evaluation of full scale honeycomb components with the coatings. Testing will be conducted using appropriate test stand or rig capable of loading the components and simulating adverse weather conditions. Estimate cost effectiveness of the coating on rotor blade life cycle.

PHASE III: Flight/Field test selected honeycomb structures, such as rotor blades and floor panels, to demonstrate and validate the coating. Evaluate the cost effectiveness of the coating and finalize a coating specification.

POTENTIAL COMMERCIAL MARKET: Technology developed from this program will have equal military and commercial application since water leakage and entrapment is a common problem.

OPERATING AND SUPPORT COST REDUCTION: Water leakage and entrapment results in core damage to honeycomb structures, requiring expensive repairs to the core. For example, rotor blade's have a typical phase maintenance interval of 500 hours, but more blades only make 300 to 400 hours before requiring maintenance. Water damage of the honeycomb core is a common problem. The use of a sealant to prevent the water damage will help honeycomb components reach their design life, reduce maintenance actions, and result in O&S cost savings.

A96-156 TITLE: Active Harmonic Suppression Motor Controllers

CATEGORY: Exploratory Development

OBJECTIVE: Develop advanced variable speed motor controllers with active control of input line current harmonics.

DESCRIPTION: The Army has a need for advanced motor controllers that incorporate active harmonic control. These controllers will be used in Environmental Control Units (ECUs) on tactical electronics shelters. The controllers allow operation of the ECUs on multiple types of input power. The controllers also allow "soft start" of compressors and fan motors in the order to prevent voltage deviations in mission equipment, but control of line current harmonics is also critical for this mission equipment. The Army has already developed Pulse Width Modulated-type (PWM) motor controllers that meet most of the desired requirements; however, passive filtering of the harmonics currently imposes a weight and volume penalty. Active control offers an opportunity to decrease the size and weight of the ECUs. Active harmonic suppression also increases the efficiency of the motor controller. These controllers must be rugged and reliable in order to operate in extreme climatic conditions; current commercial hardware is not suitable for tactical use.

PHASE I: Prepare design/circuit analysis of motor controller to incorporate active harmonic suppression, variable voltage/variable frequency output, and multiple power inputs. Design analysis should also address potential EMI concerns. heat rejection, and least-cost considerations.

PHASE II: Fabricate prototypes and test to ensure requirements have been met. Prepare detailed purchase description to allow purchase of desired capability. It is anticipated that initial government production would give contractor expertise and tooling required to begin commercial production. Majority of contractors capable/active in this area already have commercial markets established.

POTENTIAL COMMERCIAL MARKET: Successful development of this technology has a large, immediate, commercial market potential. As variable speed drive technology has proliferated across industry, problems have surfaced with harmonic current interaction with other facility equipment. Variable speed ECUs in input Army that drives are currently used in various manufacturing industries, the chemical industry, and in the textile industry. In addition, many heating, ventilation, and air conditioning systems (HVAC) in commercial buildings use variable speed drives. Active harmonic control offers the promise of increasing potential applications for variable speed drives, as well as decreasing the operating costs for current applications. We therefore believe that this effort will have very good technology transfer potential.

OPERATING AND SUPPORT COST REDUCTION: The Army has a need for advanced motor controllers that incorporate active harmonic control. The controllers allow operation of tactical Environmental Control Units (ECUs) on multiple types of input power, and allow "soft start" of compressors and fan motors in the ECU's in order to prevent voltage deviations in electronic shelter mission equipment. Control of input line current harmonics is also critical for this mission equipment. The Army has already developed Pulse Width Modulated-Type (PWM) motor controllers that meet most of the desired requirements; however, passive filtering of the harmonics currently imposes a weight and volume penalty. Active control offers an opportunity to decrease or eliminate this penalty, which would result in a lighter shelter or increased shelter payload. Active harmonic suppression also increases the efficiency of the motor controller and the ECU, resulting in less total energy consumption over the life of the system. Active control of harmonics allows less harmonics in the electrical supply of the tactical shelter; this should provide higher reliability and longer service life for every piece of electrical equipment, from generators to radios. Early elimination and control of harmonics will have many long-term benefits, especially considering the proliferation of electronic equipment in the digitized battlefield.

A96-157 TITLE: Heavy-Duty Lightweight JP-8 and DF-2 Fuelled Engine(s) With Power Range 6-200 HP for Mobile Power Generation Equipment

CATEGORY: Exploratory Development

OBJECTIVE: Develop heavy-duty lightweight JP-8 and DF-fuelled engine(s) for Mobile Power Generation Equipment such as vehicle mounted or dismounted Auxiliary Power Units and Tactical Generators.

DESCRIPTION: The engines to be developed should be already in prototype stage. Their durability should be reflected by a predicted 3000 hours Mean Time Between Overhauls and their reliability should be revealed by a calculated Mean Time Between Failures of at least 1000 hours. The weight/power ratio should not exceed 2:1. The break specific fuel consumption (BSFC) should not exceed.45 lb/HP x hr for engines up to 20HP and.35 lb/HP x hr for the larger engines. The engines shall start and operate in temperatures between -250 F and 1250F.

PHASE I: Describe in detail the engine concept and thermodynamic cycle. Include preliminary test results of the prototypes that you already fabricated. Depict the development steps necessary for achieving the desired performance and physical characteristics.

PHASE II: Describe the commercial market potential competitiveness of this new engine. Describe in detail the development work. Describe in detail the engine testing. Provide 5 (five) prototypes for evaluation.

POTENTIAL COMMERCIAL MARKET: The lightweight diesel fueled engines have practically unlimited potential commercial market in all the industrial equipment applications (i.e., generators, compressors, pumps, etc.), farming equipment, recreational vehicles, ultralight airplanes and maybe even the automotive industry.

OPERATING AND SUPPORT COST REDUCTION: If successful the new type of engine(s) resulting from this effort will have a longer life than the engines presently used in the electric power generation, therefore, providing spare parts savings. In addition, they will be more fuel efficient and environmentally friendly. Other fuel savings will result from the transportation of lighter weight equipment.

A96-158 TITLE: Migration of the Joint Task Force Communications Planning and Management System (JCPMS) to Current Commercial Technologies (NDI/COTS) and Standards

CATEGORY: Exploratory Development

OBJECTIVE: Develop a network management model to convey the current commercial technologies (NDI/COTS) and standards to the JCPMS modular concept and architecture.

DESCRIPTION: The ISYSCON program has been chosen as a baseline to provide the JCPMS capabilities. The JCPMS modular concept will be employed, and different modules within the joint system will perform unique functions. Each Commanders-in-Chief (CINCs) or Service can add any unique functionality to JCPMS to create it's own unique module. Maximize the use of NDI (Non Development I tems) and COTS (Commercial Off-the-Shelf) items will save the Government cost and time

PHASE I: Feasibility studied, research, evaluate and demonstrate the current commercial technologies by creating a network management model for JCPMS program

PHASE II: Implementation of the Phase I JCPMS model to the current commercial technologies (NDI/COTS) and standards and conduct testing with the users (Commanders-in-Chiefs (CINCs) or Services) for the verification of product.

POTENTIAL COMMERCIAL MARKET: NDI/COTS for JCPMS network management software and hardware are potentially available in the commercial market.

OPERATING AND SUPPORT COST REDUCTION: The implementation of the JCPMS model to the current commercial technologies and standards to satisfy Army materiel requirements will result in the streamlining of the JCPMS acquisition process. It will also eliminate and reduce the cost of extra research and development efforts, reduce the amount of training development costs associated with normal operations, reduce the logistic support, the setup cost for depot operation, reduce testing by using previous test and performance data provided by the manufacturer, and reduce the procurement cycle of spares and subsystem support for the support of operations involving Army equipment as well as minimize life cycle acquisition lead times.

A96-159 TITLE: Modeling and Simulation Techniques for Large-Scale Communications Modeling

CATEGORY: Advanced Development

OBJECTIVE: Streamline the Modeling and Simulation process showing optimum run times applying state-of-the-art techniques.

DESCRIPTION: Modeling and simulation (M&S) is needed to assess the effectiveness of technology insertion and the impact of doctrinal and operational changes, in support of the US Army's Force XXI Concept. Such large scale simulations, utilizing today's technology and methods, are computer resource and time intensive, in some cases requiring several days of computer run time. The purpose of this contract effort is to streamline the M&S process by developing and applying techniques to simplify large-scale communications modeling while maintaining fidelity. This will include techniques to aggregate results from brigade-level simulations to provide Division and Corps-level experiments. Techniques will also be developed for designing experiments to provide the most efficient application of resources for the issues being addressed. Data analysis and reduction tools will be developed to support post experiment analysis and documentation efforts.

PHASE I: Assess the effectiveness of technology insertion and impact of doctrinal and operational changes in support of US Army's Force XXI concept. Conduct analysis of current models for their optimum run times. Force XXI, the Army of the 21st Century, will evolve through the continuous transformation of units, tactics and equipment. A key to this transformation is the Army's increasing emphasis on the power of information. CECOM supports the evolution towards Force XXI by developing digital information systems designed to promote rapid and accurate decision making. Modeling and Simulation (M&S) is used by CECOM as an effective and cost-efficient means of supporting the development, integration, and testing of information systems required for Force XXI while mitigating risks associated with their fields.

PHASE II: Build and demonstrate the capability of optimizing run times.

POTENTIAL COMMERCIAL MARKET: Stream line the software for commercial uses in Industry, businesses, and medical applications.

OPERATING AND SUPPORT COST REDUCTION: Modeling and simulation (M&S) is a cost- effective expedient for specifying, designing, and developing the C3I systems and architectures required for the 21st century force (Force XXI). M&S allows the materiel developer to perform trade-off and "what if" analysis prior to expensive field testing with hardware. While current M&S techniques realize cost savings over traditional development methods, further advancements in OSCR must be made to realize the full potential M&S. M&S of large-scale networks can be resource-intensive, requiring considerable computing power and personnel resources to set up, run, and analyze the results of simulations. As the Army moves beyond Task Force XXI and begins analyzing division- and corps-level networks of increasing complexity, the cost of current simulation techniques will rise correspondingly. This SBIR will support OSCR initiatives by reducing the costs of large-scale simulations through minimizing the computer and human resources required to develop models and perform simulations. This will be accomplished by examining methods for automating traffic input fields, aggregating simulation results, optimizing model code, applying statistical techniques to experiment design, and examining automated data-reduction/analysis techniques. Products produced under this SBIR will realize cost savings in the development, execution, and maintenance of M&S.

A96-160 TITLE: Combinatorial Biology and Genetic Super Libraries

CATEGORY: Exploratory Development

OBJECTIVE: Design and construction of genetic super libraries which mimic the complete human immune response in their ability to encode billions of antibody combinations. In vitro selection of antibodies to select pathogens, and production using recombinant techniques.

DESCRIPTION: Current biological detection systems rely on immunochemical assays which use monoclonal antibodies to detect antigenic epitopes on pathogens and toxins. The hybridoma technology required to produce these antibodies is slow, expensive and subject to the vagaries of genetic drift which often results in cessation of antibody production in an otherwise healthy culture. More recently, recombinant technology has been used to clone antibody fragments from the spleens of immunized animals. The purpose of the immunization is to bias the antibody selection process towards a particular biological agent of interest. These methods, while expedient, are still contingent upon an immunization schedule of weeks or months, and a knowledge of the identity of the threat. Given the pace of progress in biotechnology, it is possible that a unique threat may be encountered for which no detection system has been designed, and to which current hybridoma technology will be incapable of responding. It is now possible to by-pass animals completely by constructing a synthetic repertoire of antibody genes. Libraries of peptides can be prepared bio-chemically by splicing a random mixture of synthetic DNA molecules encoding the peptide of interest (e. g., receptor specific for a particular threat agent) to the gene encoding a readily expressed protein. This DNA construct is introduced into an appropriate expression system where, upon translation, the resulting peptide is synthesized as a fusion protein. Currently, one of the most common expression systems fuses the random sequences to the gene III or gene VIII coat protein of filamentous phage particles. Each viral particle contains a unique DNA sequence that encodes only a single peptide and, typically, libraries containing 108-109 different phage particles are assembled. These libraries can be screened for biological activity against antibodies, enzymes, or receptors, and affinity or activity-selection procedures can be used to isolate the phage particles expressing bioactive peptides. By their very nature, combinatorial antibody libraries in which very large numbers of different heavy and light chains are randomly combined supplicate many aspects of the mechanisms used by the human immune system. The incorporation of these libraries into surface display vectors provides the essential link between recognition and replication and thus mimic the B-cell mediated immune system selection process. Because of their high specificity, access to a much larger and structurally diverse antibody library is an important part of solving problems of recognition and stability of sensing elements.

PHASE I: The focus of this work will be the randomizing of the NCDR3 sequence, since NCDR3 is the most hypervariable region in an antibody molecule. It has been estimated that humans have the potential to generate as many as 1014 peptide sequences in this region. Additionally, HDCR3 makes the largest contribution to the total accessible surface area of an antibody combining site. The 16-amino acid sequence of the 7E HCDR3 will be randomized using PCR. The possible number of peptide sequences produced from this synthesis exceeds 1020. Antibody Fab fragments will be displayed on the surface of phage and "biopanned" according to affinity and receptor specificity.

PHASE II: The focus of Phase II will be to mature the library in order to produce high affinity clones, and to select for and express recombinant antibodies which recognize pathogenic threat agents. The library must be sufficiently diverse to recognize a broad spectrum of pathogens and toxins.

POTENTIAL COMMERCIAL MARKET: Combinatorial biology will be the primary method for drug discovery because it will allow for rapid screening of billions or trillions of compounds. This technology could also be extended to the creation of new catalytic materials for low temperature chemical synthesis, and for the creation of novel :smart: structural materials.

OPERATING AND SUPPORT COST REDUCTION: The creation of genetic super libraries would provide the ability to rapidly screen billions of compounds for recombinant antibodies which can be used to detect pathogenic threat agents. It would allow for the manufacturing of antibodies at one-tenth the cost.

A96-161 TITLE: Nanotechnology and Microelectromechanical Sensors

CATEGORY: Exploratory Development

OBJECTIVE: Develop miniature, reagentless sensors based on microelectro-mechanical systems which are self-sufficient with regard to sample handling, power supply and data telemetry.

DESCRIPTION: Currently available detection systems are large, use significant amounts of power, require complex reagent handling, are not completely automated, and are subject to interferents. Miniature, self-contained, reagentless solid state sensors are needed for incorporation into UAV sensor suites, and for remote deployment. Nanotechnology refers to the manufacture of tools on a micrometer or smaller scale and/or devices for chemical or biological recognition on the molecular scale. It frequently suggests the use of photolithographic micromachining techniques, but is not limited to devices constructed in this manner. Current focus in the field is on the micromachining of valves, pumps, flow controllers, autosamplers and sensors in order to develop an analytical laboratory on a chip. Microelectromechnical Systems (MEMS) will be the underlying technology base of this effort because of the potential for MEMS sensors to be cheaply mass produced, host multiple antibody or gene probe sites on a single chip, and contain all required sampling, microfluidics and telemetry on a miniature circuit board (2" x 2"). Initial work in the commercial sector has demonstrated a micromachined pump prototype which delivers a flow rate of 200 nl-1ul per minute using less than 10uW of power, a miniature power supply capable of delivering 1 kV over 8 hrs, and a microprocessor with telemetry on such a circuit board. Operationally, these sensors could be used in implanted stations with integrated robotic collection, in arrays conformed to air frames such as UAV's, and in hand-held, real-time assays. A key feature of MEM's technology is its ability to move samples and reagents in a manner which allows sequential analysis in order to both identify the pathogen or toxin, and also to determine viability of the organism.

PHASE I: Key issues to be resolved are selective coating of MEM structures with gene probes and antibodies, electronic oscillator damping effects due to media and background, dynamic range, micro-sampling, problems of diffusion and mixing in small volumes, piezo-electric and nanomotor devices for moving samples, and design of nanoscale optical detectors.

PHASE II: The focus will be on designing a MEMS system which incorporates biological recognition sites such as gene probes and/or antibodies for detection of biological agents, and on the micromachining and related manufacturing techniques to produce the system in mass quantities and at low cost.

POTENTIAL COMMERCIAL MARKET: MEMS systems will have broad applications in robotics, microsurgery, medical diagnostics, and sensors for the auto industry.

OPERATING AND SUPPORT COST REDUCTION: The development of microelectromechanical sensors would reduce by several orders of magnitude the amount of reagents required by chemical and biological detection systems. The resultant sensors would have less parts, require less maintenance and experience fewer disposal problems.

A96-162 TITLE: Imaging Automatic Gain Control (AGC) for Target Acquisition, Automatic Target Recognition (ATR), and Tracking

CATEGORY: Exploratory Development

OBJECTIVE: Provide an AGC method or image enhancement method for the real time creation of an "ideal image" such that target detection, recognition, and identification algorithms can function on the most optimum signature while providing the subsequent tracking function an optimal signature for handover initially and during missile reacquisition scenarios.

DESCRIPTION: Typical image generators, such as TV cameras and infrared imaging devices produce a considerable image dynamic range which may vary significantly, however, the target signature of interest may subtend a small or large portion of this range and in addition be at any relative position within it. In general, this produces problems both in the human perception and automatic consumption and use of this data. The potential for the image dynamic range and the target within to change drastically based on current methods used for gain control in imaging devices is quite high, where the intent of this effort is to minimize these changes and maximize the target signature(s) simultaneously.

PHASE I: Evaluate current methods which may lend themselves best to the ATR scenario. The contractor shall test, evaluate, and quantify computational requirements, dynamic range limitations, and hardware architecture requirements (including size, weight, and power) of currently implemented AGC methods and explore new methods appropriate for the optimization of target detection, recognition, and identification. Itemize limitations and provide modifications or new methodology that will allow a more optimum signature to be made available for both the ATR and the handover for tracking.

PHASE II: Implement, in real time hardware, the best AGC method selected in Phase I using an infrared camera.

POTENTIAL COMMERCIAL MARKET: There are significant potential commercial uses for the technology developed under this SBIR scope of work title. Some of the commercial uses are surveillance and security, robotics, advanced sensors development, and automated assembly line parts inspection.

OPERATING AND SUPPORT COST REDUCTION: The operating and support costs can be significantly improved by insertion of the technology produced under this SBIR topic although the topic technology is related only indirectly. The implementation of this SBIR topic technology will provide a significantly improved kill probability of the deployed missiles which have it incorporated. In addition, the missile fire control target acquisition system will have an increased survivability and consequently a reduced vulnerability because of the improved target acquisition and tracking capability. This added capability will clearly reduce unit replacement costs and therefore unit support cost. Additionally, the operational costs will be reduced because of a further minimization of operator fatigue due to loss of target lock and false alarms that will also be reduced.

A96-163 TITLE: Infrared Background Clutter Metrics

CATEGORY: Exploratory Development

OBJECTIVE: To investigate and develop infrared scene clutter metrics for analyzing the performance of imaging infrared seekers utilizing staring focal plane arrays (FPA) in particular, and imaging infrared sensors in general.

DESCRIPTION: There has been a large investment by the DOD in FPAs and other imaging infrared sensors over the past several years. Although excellent analyses tools exist for describing the imaging sensor themselves, no adequate method exists for characterizing the performance of the sensors against targets in clutter. This is due, for the most part, to the fact that there is no agreed upon set of clutter metrics which describe the clutter and target to the extent that they may be discriminated from one another. Past efforts based on local first order background statistics (i.e. Schmieder-Weathersby, etc.) have achieved some success with point source targets but are not sufficient for predicting performance against spatially resolved targets. An approach which considers higher order image statistics and spatial frequency domain characteristics might more completely describe the relationship between a resolved target in a complex background. A set of image based clutter characterization metrics which help discriminate point sources and resolved targets from their clutter backgrounds in both single-band and multispectral imaging situations is desired. These metrics are needed to quantify the clutter for use for sensor models for both defense and commercial applications. The defense applications include performance analyses of target acquisition, tracker algorithms, aimpoint selection, autonomous target recognition (ATR) algorithms, and multispectral seekers. Commercial (non-DOD) applications include forest fire detection and crop/land use surveys and assessments from satellite imagery, machine vision for industrial applications (robotics, automatic assembly, sorting), and medical imaging analysis and interpretation.

PHASE I: Provide detailed analysis of background clutter and develop a set of theoretical metrics based upon those analyses. Utilize the metrics to predict imaging infrared seeker performance and/or operator image assessment. Develop a plan for validating the metrics in Phase II including data sources, equipment and analytical software, and proposed experimental and analytical techniques.

PHASE II: Implement the plan for metric validation which was developed in Phase I. Fabricate or purchase hardware and software for conducting background clutter investigations and to demonstrate the experimental techniques for background characterization. Conduct the validation testing to relate the background metrics to machine and/or human performance.

POTENTIAL COMMERCIAL MARKET: In addition to missile seeker applications, this item can be used on any infrared imaging sensor to improve the sensor performance and improve operator effectiveness. This includes intrusion devices, law enforcement night viewing devices, forest fire detection devices, satellite imagery evaluation, etc. Other markets include machine vision for industrial applications (robotics, automatic assembly, sorting), and medical imaging analysis and interpretation (improved diagnostics using ultrasound, CAT, PET, MRI, and Xray imagery).

OPERATING AND SUPPORT COST REDUCTION: Current background descriptions for use in imaging infrared sensor/seeker simulations, tactical decisions aids and training packages are not standardized and in most cases are obtained by direct measurement of selected backgrounds. Not only is this an expensive approach, it limits the number and variety of backgrounds that can be described adequately. It is further limited by the availability of data taken during various environmental conditions. An approach is desired that allows composite infrared background scenes to be synthetically generated from a data base of background objects and types. Before this can be accomplished, a set of background metrics must be identified that allows appropriate measurements to be made. Given that these metrics can be identified there is a wealth of calibrated imagery available for reduction and analysis. The opportunities for cost savings are outstanding; aside from the obvious utilization of these metrics in missile seeker simulations, they can be applied to generating backgrounds for use in virtual reality facilities. The level of effort and cost for continuing IR background measurements in support of the practical use of Army smart IR weaponry will be reduced with success under this proposed SBIR task.

A96-164 TITLE: Virtual Reality Scene Generation By Means of Open Standards

CATEGORY: Engineering Development

OBJECTIVE: Commercially available packages for Virtual Reality applications typically attempt to address the widest possible portion of users. Consequently such packages are large and unwieldy and are not suitable for real-time applications such as high fidelity missile simulation. Moreover, many such packages are written using proprietary software libraries such as Silicon Graphics' Performer. A small, compact software package based on Open Graphics Language (OpenGL) is needed for applications that require high speed and a high degree of portability among platforms. The purpose of this SBIR is to demonstrate such a package in an infrared imaging missile system simulation.

DESCRIPTION: A virtual world consisting of thousands of textured polygons must be created in order to perform simulations for imaging missile systems. As the missile system flies through its trajectory, changes in range and attitude result in a continually changing image to the missile sensor. The real-time simulation must generate, through projection or injection, an image to the missile system at a very high rate, typically 150 hertz or higher. The simulation must transform its virtual world into a planar image expected to be seen by the missile sensor. This computation must be performed in real-time for each simulation update cycle. The computational power to do this in real-time has traditionally required use of multi-million dollar, special purpose hardware and software. As more and more imaging missile systems required hardware-in-the -loop simulation, building multi-million dollar scene generators is no longer a viable solution. Commercial off-the-shelf (COTS) hardware products such as the Silicon Graphics Onyx are now capable of performing the required computations in real-time at a fraction of the cost of some specialized custom scene generators. High performance graphics subsystems now being developed for Personal Computers (PCs) will soon be available to a large number of users at a low cost. The Integraph TDZ series and the Silicon Graphics Impact series workstations are recent examples of this trend. However, current COTS software packages are typically too large and cumbersome to render the data at the required rates. Clearly, a fast, compact package is needed to address the segments of the Virtual Reality community that require higher speeds, higher portability, and lower costs. This SBIR requires that a software package be developed to meet the stated speed and portability goals. The resulting package must be suitable for use with imaging infrared missile systems for which hardware-in-the-loop simulation is expected to be performed at the Advanced Simulation Center (ASC).

PHASE I: Develop scene generation software using open graphics standards on a Government Furnished Silicon Graphics Onyx that includes four processors and two raster managers. The scene generator shall include the following: (a) a virtual world consisting of at least 100,000 textured polygons shall be obtained as an input to the scene generator. (b) The system shall be capable of culling 2000 textured polygons from the virtual world of 100,000 textured polygons and rendering 2000 textured polygons for each simulation cycle at a deterministic 105 hertz throughput rate. The entire scene shall be re-computed for each simulation cycle at a 150 hertz rate with no missed cycles throughout an entire missile flight, including endgame. (c) Capability to support texture with a resolution of at least 12 bits shall be included. (d) The system shall be capable of varying the field of view from one to twenty degrees. (e) A complete set of documentation, including computer source code and user manuals, shall be provided.

PHASE II: In Phase II the Virtual Reality Scene Generator (VRSG) shall be integrated with an actual hardware-in-the-loop simulation for an imaging missile system. This effort shall include the following: (a) creation of a Virtual World with suitable targets and backgrounds for the particular missile systems to be evaluated in hardware-in-the-loop simulation (b) digital interface of the VRSG to an imaging projection device (c) integration of VRSG with a simulation control computer (d) investigation of the signal processing characteristics of the missile system to be evaluated to ensure that requirements are met (e) verification that the VRSG portion of the hardware-in-the-loop simulation is operating properly and is producing the correct results (f) upgrade of the throughput rate to be capable of rendering 2500 textured polygons at a sustained, deterministic rate of 200 hertz.

POTENTIAL COMMERCIAL MARKET: Virtual Reality (VR) is one of the largest growth industries in the United States today. While several VR software packages are commercially available, most are very large in size and often utilize proprietary hardware and software. Many users need a smaller, more compact VR software support package that is portable to many different computer platforms. The objective of this SBIR is to provide this type of software support for scene generation applications. Potential commercial users fall into three categories. The first category includes those who need to produce imagery at high throughput rates. Pilot training, entertainment, weather, and medicine are examples of this group of applications. The second category of users includes those who need portability among platforms. Many VR software support packages use proprietary software such as Paradigm Vega, Coryphaeus EZScene, Gemini GVS, and Sense8 WorldToolkit. Using OpenGL as a software standard, the package produced under this SBIR will be available to almost every commercial computer platform, including Personal Computers. The third category of users includes those who cannot afford large, expensive software package. This inexpensive scene generation software will reach a large number of users for which currently available software is cost prohibitive. Millions of commercial applications fall into one of these three categories. By advancing the state-of-the-art in high speed, low cost, open architecture scene generation, this SBIR will serve a significant segment of the VR community.

OPERATING AND SUPPORT COST REDUCTION: This Virtual Reality Scene Generation (VRSG) will reduce Operational and Support (O&S) costs enormously over the life cycle of U.S. Army weapon systems by several different means. The first of these is mission planning and rehearsal. A low cost method of generating a virtual world will greatly improve effectiveness of military mission planners by providing a realistic vision of the landscape and conditions involved in the mission scenario. Satellite imagery data can be utilized with the VRSG system to provide a realistic synthetic environment to the military planner. Users can than "walk through" the battlefield environment with a variety of options. Such a tool will greatly enhance situational awareness to the extent that effective military missions can be developed at a much lower cost. Another O&S cost reduction potential of the VRSG is in the area of training. Soldiers can be trained to operate both visual and infrared weapon systems using the VRSG. This training can be performed over a wide range of scenarios including adverse weather conditions. The low cost, portability, and high speed capabilities of the VRSG lend themselves well to establishment of such capabilities at a large number of sites. Another key cost reduction potential of the VRSG system is in the area of stockpile reliability testing (SRT). In order to effectively measure the effectiveness of an infrared weapon system, it is necessary to present realistic imagery to that system in real-time. The VRSG will generate such imagery, so that SRT can be performed at a fraction of the cost of a flight test. SRT typically represents a large portion of the cost of a weapon system over its life cycle, so the VRSG cost reduction would be of very significant benefit.

A96-165 TITLE: Plastic Encapsulated Microcircuit Storage Accelerated Age Model

CATEGORY: Exploratory Development

OBJECTIVE: Develop an accelerated age model, for storage risk assessment of plastic encapsulated microcircuits, that accounts for the various environmental conditions present in military storage environments.

DESCRIPTION: With the current push for the use of Plastic Encapsulated Microcircuits (PEMs) in weapon systems, efforts to gather data on the behavior of PEMs in military storage environments have begun. These efforts involve real time age storage programs which consume time. An accelerated age model would reduce the time needed to gather data for the risk assessments on the use of PEMs in weapon systems. The accelerated age model, as a minimum, should account for temperature and humidity cycling. Other environmental stresses to consider are atmospheric pH levels, atmospheric salt levels, and extreme hot and cold temperatures for various lengths of time. The accelerated age model should also be tailorable to specific environments. (i.e. tropic, arctic, desert).

PHASE I: The accelerated age model should be developed through research in the physics of failure of plastic encapsulated microcircuits. The model should also be developed for use on computer with provisions for input of all parameters.

PHASE II: The Accelerated Age Model (AAM) should be tested by inputing known data from actual age plastic encapsulated storage tests. The results from the AAM should be compared to the results from the actual age test to verify the correctness of the AAM. The AAM should also be tested by inputing projected environmental data for an actual age test at its beginning stages. The results from the AAM could then be compared to the results obtained at the completion of the actual age test.

POTENTIAL COMMERCIAL MARKET: Plastic encapsulated microcircuits are used widely in commercial industries in such areas as computer systems, avionics systems, and automotive electrical systems. Replacement assemblies for these systems are stored until needed and can sit in storage for long periods of time. An accelerated age model for plastic encapsulated microcircuits can be used to predict degradation of electronic assemblies in storage, and can help in determining the overall shelf life of electronic assemblies.

OPERATING AND SUPPORT COST REDUCTION: A Plastic Encapsulated Microcircuit (PEM) accelerated age model will provide operating and support cost reductions over the life cycle of a weapon system built with PEMs. There is an unknown risk associated with the use of Plastic Encapsulated Microcircuits (PEMs) in weapons systems subject to long term dormant storage. The development of a PEM accelerated age model will allow for the timely assessment of the risk to weapon system reliability when PEMs are used. This could provide a tremendous savings by preventing the retrofitting of numerous weapon systems that may develop reliability problems due to the failure of PEMs from long term dormant storage. On the other hand, if the PEM accelerated age model shows that a PEM will meet reliability requirements, the use of the PEM in a weapon system will provide a savings. This is due to the lower cost of a PEM when compared to its ceramic counterpart. Finally, other programs funded by weapon system project offices that involve actual age and accelerated age testing of PEMs can be eliminated after the development of a proper accelerated age model.

A96-166 TITLE: Low Energy Impact Damage Evaluation of Thin Walled Composite Structures

CATEGORY: Basic Research

OBJECTIVE: To develop and validate analytical methods to predict the development of structural damage caused by low energy (<15 ft.-lb) impact and the resulting loss in post impact performance of composite pressure vessels, i.e. rocket motor cases, cylinders/tanks, pipes, etc. Such models can be used to optimize the design of composite pressure vessels with significantly improved damage tolerance capability.

DESCRIPTION: Experimental testing has shown that composite materials exhibit a very real susceptibility to structural damage caused by low energy impact. Where system weight is a critical factor, as in rocket motor cases, structural designs are often developed with minimal (1.5 to 2) safety factors. Therefore, it must be assumed that any incidental impacts have the potential to render a structure unusable. With the costs associated with composite systems, any loss of assets are unacceptable. Analytical models which incorporate dynamic analysis, failure analysis and micromechanical models appropriate for use with composites are required to fully understand the phenomena and determine design enhancements for survivability.

PHASE I: Impact damage in a composite structure is a combination matrix cracking, fiber breakage and delamination. The Phase I objective of this work should be directed towards the development of methods to identify the type and extent of damage in a structural component based on the velocity, geometry, and the material of the impactor, and the structural and material configurations of the target.

PHASE II: The results of Phase I should be used to determine the effect of various failure modes on the post-impact burst pressure capacity of composite tubes. This entails the performance of stress analyses near damages of idealized shapes, and development of realistic fracture and failure models. This effort should result in deliverable analytical models which provide for the identification of the predominant material/structural interactions contributing to improved impact damage tolerance.

POTENTIAL COMMERCIAL MARKET: Composite materials are becoming increasingly accepted for use as structural materials in a variety of industries. While military applications encompass rocket motor components and hardware, additional uses for composite pressure vessels are found in both the aerospace and automotive sectors. For example, the high strengths and light weights associated with composites make them ideal candidates for use in space flight hardware as containers for fuels and other pressurized gases. With the environmental concerns over the use and depletion of fossil fuels and the dependence of the

United States on foreign suppliers, automotive uses include fuel cylinders for LPG powered cars and trucks. Use of composite materials is not limited to just pressure vessels, other structural components can be fabricated in a wide assortment of shapes to provide for a variety of uses (Airline and Construction). If these uses happen to be as load bearing components, it is imperative that the integrity of the structure not be questioned. As it stands now, there is no method available to predict the structural response, i.e. residual strength, of a composite subjected to impact. The analytical models which result from this SBIR can help ensure the continued acceptance and safe use of composite materials.

OPERATING AND SUPPORT COST REDUCTION: The overall goal of this SBIR topic fully supports DoD OSCR initiatives. While the analytical models to be developed under this SBIR are intended to be implemented in the design stage of future tactical systems, benefits can be expected throughout the operational life of the system. It has been shown through extensive testing that low energy impacts can have a serious detrimental effect to the operational performance of composite rocket motor cases and launch tubes. Visual damage caused by impact can take the form of matrix crazing, fiber breakage or delamination. As structural composites generally incorporate alternating layers of fiber, sub- surface damage may not be evident. Therefore, it must be assumed that any incidental impacts have the potential to render a structure unusable. The analytical models which will result under this SBIR will provide the motor case/launch tube designer with tools to determine methods for improved impact damage tolerance. Damage tolerant composites systems will not have to be removed from service for replacement. Savings can be expected through reduced replacement costs, i.e. rocket motor cases and launch tubes, system down time, required man-hours, etc. Perhaps more importantly, enhanced mission readiness can be expected throughout the life of the system. This SBIR has the potential to provide "factory to the field" benefits.

A96-167 TITLE: Demonstration of Optical Control of Steerable Array Antennas

CATEGORY: Exploratory Development

OBJECTIVE: The development of optically based antenna beam steering architectures has been the subject of laboratory research for nearly twenty years. This work has achieved the critical mass necessary to begin experimental development/demonstration outside of the laboratory. The objective of this topic is to acquire an optically based beam steering system capable of controlling the phased array antennas currently proposed for the next generation Army air defense radars, Federal Aviation Administration (FAA) air traffic control radars, and commercial weather radars.

DESCRIPTION: The goal of this effort shall be to design, fabricate, and test a two dimensional steerable array including the beam steering equipment. The array shall be steerable in both azimuth and elevation. The beam steering architecture shall be optically based and capable of supporting wide bandwidth waveforms with a center frequency above 18 GHz.

PHASE I: The goal during Phase I is to create a producible design for the above described antenna. This effort will include computer modeling to predict the antenna's expected performance.

PHASE II: Phase II will have two goals. First, the fabrication of the antenna designed in Phase I. Second, the testing of the antenna on an antenna range.

POTENTIAL COMMERCIAL MARKET: This technology has potential commercial use for all applications involving non-mechanically steerable antennas. The two most notable applications are FAA air traffic control radars and commercial weather radars.

OPERATING AND SUPPORT COST REDUCTION: Optically controlled array antennas offer several operating and support cost reduction opportunities. The devices currently used in electronically controlled array antennas are a cost driving item. Current projections indicate the optical devices that will replace them will be significantly less expensive; thereby, reducing both purchase and repair costs. In addition, optically controlled array antennas will be lighter in weight than their electronic counterparts. This will result in both lower transportation costs per unit as well as increasing the number of units that can be transported per transport. Also, optically based systems typically require less prime power than their electronic counterparts which will reduce their basic operating cost.

A96-168 TITLE: Pulse-Coupled Smart Pixel Array

CATEGORY: Basic Research

OBJECTIVE: Design, build and test a 64x64 smart pixel array, based on pulse-coupled neural network models, which can generate pulse-train outputs for image transforms and analysis.

DESCRIPTION: The Pulse-Coupled Neural Network (PCNN) models (see references) have significant applications in image processing and analysis. They have been implemented in recent years as small integrated circuits on electronic chips so that one- and two-dimensional arrays of the basic circuitry were formed. These proof-of-principle units showed that speeds of 1 MHz and greater were possible, and gave a technology and circuit design base for similar circuits and significantly larger arrays. The work required to be done consists of performing further circuit and chip layout design, building the arrays, bonding and mounting them upon return of the dies from the chip foundry, providing the necessary control and power sources and control panels, and measuring the array outputs for a small test set of sample imagery. The arrays must include photodiodes at each pixel and, also at each pixel, either a direct optical readout mechanism such as a laser diode or liquid crystal cell or a shift register mechanism that permits real time readout of the pulse activity over the array.

PHASE I: Perform the design. The design is a deliverable item.

PHASE II: Build the array, integrate, and perform the tests. Deliver all reports and hardware.

POTENTIAL COMMERCIAL MARKET: The PCNN chips would enable robotic vision, machine vision, visual aids for the visually impaired, automobile navigation and obstacle avoidance, and automatic object recognition systems for commercial applications such as face, fingerprint, and retina recognition.

OPERATING AND SUPPORT COST REDUCTION: The objective of this SBIR topic is to develop an electronic microchip which performs data processing on an image when a camera lens images a scene directly onto the area of the chip itself. The overall goal of the research project is for automatic military target recognition, but it can apply equally well to automatic recognition of any object in the scene. Accordingly, this research indirectly supports a variety of potential applications which can reduce operational costs and promote efficiency of operation involving U.S. Army equipment. Examples are automatic machine vision systems for locating parts and equipment in warehouses, personnel aids for automatic form-reading systems, automatic continuous surveillance monitoring of storage yards, and other routine surveillance that would otherwise require trained personnel and their associated man-hour costs. These OSCR benefits are indirect, and OSCR is not the primary thrust of this research, but there are viable future applications of this technology that can support OSCR.

A96-169 TITLE: Doppler LIDAR Using Edge Technique

CATEGORY: Engineering Development

OBJECTIVE: The objective of this effort is to develop and build a reduced eye-hazard Doppler LIDAR using the "edge filter" technique for determining wind velocity and turbulence in areas of interest over ranges between 1-10 plus kilometers. The spatial resolution of the LIDAR should be on the order of 3 meters and a velocity resolution on the order of 10-20 cm/s. The purpose of this system would be to aid in the detection of masked targets (i.e. helicopter) or atmospheric disturbances from signatures due to exhaust, debris particles displaced by the target(s), and/or disturbances caused by natural environmental phenomena.

DESCRIPTION: The LIDAR system should consist primarily of an eyesafe laser, telescope, receiving and transmitting optics, receiver, broadband edge filter technique using an etalon filter or equivalent, receiver(s), and a data collection and reduction mechanism which should include data processing, software, computer, etc. The system shall be portable and eye-safe, and have a performance range of 1-10 plus kilometers. The masked target will either create its own wind or turbulence, disturb the natural wind currents, and/or cause vibrations, thus making a detectable signature(s) for a Doppler LIDAR.

PHASE I: Phase I should consist of research and studies that lead to a design that will meet the needs as described in the Description above. This research and studies shall determine what components are required, the cost of the components, conceptual design based upon findings (including form, fit, and function), growth potential, risk factors (both technical and phenomenological) and their relevance, propagation at the selected wavelength as influenced by environments, data processing assessments, establishing LIDAR performance tradeoffs with range, scan times, optic size, and weight; a model of the performance of the system, and a final report.

PHASE II: Phase II should be the building of the LIDAR system, performing signature tests with the system against objective targets, provide a complete system to the Optics and Laser Technology Area of MICOM's Research, Development, and Engineering Center, and a final report documenting the LIDAR operation procedures and the results of the system tests.

POTENTIAL COMMERCIAL MARKET: There is a need for a device that remotely determines the wind velocity in aviation. Aircraft must avoid vortices that are created by other aircraft, clear air turbulence avoidance and micro burst weather conditions that may lead to unstable or upsetting flight conditions. This system has the potential to be sufficiently sensitive that it may provide threshold signatures that may act as a precursor for adverse atmospheric conditions.

OPERATING AND SUPPORT COST REDUCTION: LIDAR technology is a rapidly growing sensor field. Proof of principle tests have been completed using the edge technique in a bread board Doppler LIDAR. A system such as the one submitted that can accurately profile the wind and wind currents will greatly increase the effectiveness and accuracy of existing missile systems in the field. Having an increased effectiveness and accuracy will possibly decrease the number of missiles that are needed and thus decrease the number needed to be fielded along with the logistic burden. A Doppler LIDAR could also possibly have application in military and commercial aircraft for clear air turbulence avoidance that is created naturally and by other aircraft. In addition a Doppler LIDAR could possibly be used in aircraft to map the wind to allow aircraft to fly the nap of the earth because down-drafts and other wind disturbances could be predicted before they are encountered. It would also increase their survivability. This same technology may also have capability for monitoring the weather for related down bursts at airports. The enhanced sensitivity of this LIDAR may provide early threshold signatures of turbulence that exceed existing techniques. Another possible benefit would be the increased capability of detecting masked targets and being able to engage them before they are able to destroy our soldiers and equipment. This program supports OSCR through potential cost savings of army equipment and personnel.

A96-170 TITLE: Environmental Stress Monitoring, Analyzing, and Recording System for Missile Applications

CATEGORY: Advanced Development

OBJECTIVE: Develop on autonomous environmental stress monitoring, analyzing and recording system for use in fielded and stored tactical missiles and associated support equipment. This technology should provide cost-effective prognostic capability concerning the environmental integrity of the missiles and associated support equipment. Commercial use could benefit from detection of environmental stress degradation of bridges, buildings, and power poles.

DESCRIPTION: As missiles, their components, and associated support equipment have increasing shelf and storage life requirements, and become more complex and costly, it is necessary to ensure that maintenance is not unnecessarily done or is done when needed. To determine the physics of failure and an estimated time to failure, an environmental stress exposure history is required. A method of non-intrusion querying is needed to collect this data for tactical missiles. As an integral part of the missile and support equipment this technology would allow the assurance that the missile has not degraded because of environmental stress. The system should allow the data to be retrieved directly from the missile or support hardware or by a remote system that would allow data to be gathered on a real time basis. This system will provide more accurate data to determine missile and support equipment shelf life, spare parts planning and missile health. This will result in optimizing part of the life cycle costs.

PHASE I: Leverage previous technology efforts in time stress measurement devices and microelectromechanical sensors (MEMS) to develop and design an environmental stress measurement system capable of self powered autonomous operation for 5 to 10 years. The system shall be capable of monitoring, analyzing and recording multiple stress types from several internal locations, and make the data retrievable at any time. The environmental stresses shall include, but not be limited to: temperature, shock and vibration, and humidity stress.

PHASE II: Construct and test the system. Fully test the system capability at environmental extremes and in natural environments. Use data to optimize the design.

POTENTIAL COMMERCIAL MARKET: Bridges suffer from the vibration stress of the automobiles driving over them. With this technology the bridge could be monitored for degradation due to stress. When the stress caused damage to the bridge the monitoring equipment would detect it and could report that the bridge needed repair. This would cut the cost of inspection and down time of the bridge. Unmanned pump stations would benefit in that the monitoring equipment would detect when the equipment failed or the flow rate decreased and notify that it needed repair. Both of these examples would notify the personnel

that the item that it is monitoring is in need of repair or attention, thus, it would cut down on the amount of inspection time and inspection personnel.

OPERATING AND SUPPORT COST REDUCTION: Because the stress monitoring system will have remote communication ability to inform the necessary personnel if a failure has occurred, the number of inspections required, the number of personnel and the amount of man-hours required to perform the inspections will be reduced. Also, by utilizing data from the system, a model could be developed to allow prognostic capability and estimation of failure time of the hardware. Having an estimation of when a piece part or piece of hardware may fail would allow that defect to be designed out early in the hardware's life-cycle. This would make the hardware more reliable, extend the life of the hardware and reduce down time caused by failures. The hardware would require fewer spare parts and reduce eventual replacement quantity.

A96-171 TITLE: Generic Ducted Rocket Test Facility Combustion and Flow Prediction/Analysis System

CATEGORY: Exploratory Development

OBJECTIVE: Development of a Windows-based system for the prediction and post test analysis of high flow rate air breathing combustion systems, such as ramjets and ducted rockets, with interactive GUI based flow system configuration.

DESCRIPTION: Interest in high flow rate air breathing propulsion systems has greatly increased over the past several years, and has resulted in a corresponding increase of static testing and analysis. Presently, test facilities expend excessive amounts of effort in the pre-test planning and analysis of acceptable hardware configurations, post test data reduction, and correlation of results with predictions. Typically, an air breathing missile test facility consists of several primary systems: an air heating and delivery system, a fuel delivery system, a combustion chamber, and an ejector for altitude simulation. Specifically, a tool is required that operates under the Windows environment that utilizes a convenient, and logically designed Graphical User Interface (GUI) for the configuration of the test geometry that would simulate full scale missile flight conditions. The program should generate an instrumentation requirements list and display proper instrumentation locations upon the GUI built representation of the test facility. The user interface shall take full advantage of the Windows environment and be graphically based to the maximum extent, including "drag and drop" assembly of the primary components of the test facility. The system shall provide for the convenient and rapid graphical configuration of the air flow system, fuel flow delivery systems, and test article geometry. Fuel delivery systems may be either liquid, gas or solid. Solid fuel delivery systems would require a basic combustion chamber ballistics analysis to insure proper fuel flow rates, and prevent over pressurization of the test facility fuel gas generator hardware. Integration of a chemical equilibrium code will be necessary in order to set combustor nozzle geometry and chemical gas constants for any fuel/mixture and composition. A library of locally existing hardware, such as "in hand" combustion chamber hardware, air chokes and nozzles available, should be available for use in the assembly and optimization of the test facility representation. The output interface shall provide various graphical and tabular format options. It is required that tabular output can be conveniently exported to other Windows applications (spreadsheet and word processor) for incorporation in other documents. Facility generation parameters would include air and fuel flow rates, air and fuel flow velocities through the facility, predicted temperatures and pressures, nozzle, constriction and choke sizes, physical hardware dimensions, and predicted gas constants and parameters. Post test analysis would include reporting of C*, Thermal, and Expulsion efficiencies, measured gas flow characteristics of both the air and the fuel gas, and Chemical Equilibrium Code calculations of the dynamic gas values of the input air, the fuel gas, and the combustion process.

PHASE I: Under the Phase I effort the GUI for the configuration and optimization of the test facility shall be delivered. This includes full development of the GUI based "drag and drop" features and instrumentation list generation for the facility representation. A configuration file should be generated for use by the analysis program to be produced in Phase II. To support the evaluation of the delivered software, all hardware, commercial software, custom software (including source code) required to develop and run the system shall be delivered to the Government.

PHASE II: Under the Phase II effort a fully functional facility design/analysis system shall be developed and demonstrated that incorporates all the desired features. To support the evaluation of the delivered software, all hardware, commercial software, custom software (including source code) required to develop and run the system shall be delivered to the Government.

POTENTIAL COMMERCIAL MARKET: This system could be utilized by educational institutions and commercial advanced air breathing development and testing companies. Fossil fuel fired power plant design and analysis, as well as any high velocity gas flow facility would benefit greatly from the effort.

OPERATING AND SUPPORT COST REDUCTION: This topic supports OSCR initiatives associated with the normal operations involving Army equipment and man hour labor costs. The topic, if successful, will be used to maximize the material available for Ducted Rocket Testing at the Propulsion Directorate, as well as save hundreds of pre and post test Ducted Rocket Facility setup and analyze man hours. The successful completion of the project would greatly enhance the usability of the present tests systems, as well as allow for more timely, accurate, and economical ducted rocket tests.

A96-172 TITLE: Development of Fiber Optic Gyroscope Sensing Coils with Improved Thermal Stability

CATEGORY: Exploratory Development

OBJECTIVE: Develop small diameter (inner diameter 1 inch or less) fiber sensing coil design and analysis techniques which will minimize sensitivity to temperature variations and temperature-induced stresses.

DESCRIPTION: It is desirable to develop Fiber Optic Gyroscope sensing coils which are small in volume (inner diameters 1 inch or less) and designed to withstand large environmental variations over the lifetime of the sensor. When the sensing coil is exposed to temperature variations, the optical fiber undergoes both axial and radial expansions and the layers of fiber in the sensing coil pack shift and move. Pack expansion and movement limits gyroscope performance parameters such as scale factor, bias drift, and axis alignments. Lifetime and reliability of the sensing coil are also reduced as a result of the temperature flucuations.

PHASE I: Select fiber/spool materials/winding approach, analyze inner layer stresses in the coil design and select approach to minimize variations due to thermal stress. Develop and implement experimental procedures to verify design.

PHASE II: Build and test the coil design selected in Phase I, optimize the configuration. Verify the performance of the design over temperature within a gyroscope configuration.

POTENTIAL COMMERCIAL MARKET: Although the technology will enable military requirements, a commercial spin-off technology is in the automotive market for active suspension stabilization systems and map update navigation systems. This area is already starting to grow very rapidly, and it is believed that the automotive application will be significantly larger than the military application. A reliable, low cost and small-sized Fiber Optic Gyroscope will be of special interest to the automotive market. Other areas of potential market power are robotics, gyro compasses for heavy machinery and light aircraft, and oil and gas exploration.

OPERATING AND SUPPORT COST REDUCTION: The development of Fiber Optic Gyroscopes (FOGs) sufficiently good for navigation has been demonstrated in the laboratory, but advancements to achieving reliable performance over a range of environmental conditions still need to be made. The performance of a FOG is sensitive to time -varying thermal gradients present across the fiber sensing coils of a FOG. Currently, Ring Laser Gyroscopes (RLGs) dominate the market for inertial navigation grade devices and mechanical rate gyroscopes of multisensors are utilized for tactical grade devices. Advancements in thermal compensation techniques (coil design, winding techniques, etc.) may allow the FOG to quickly replace the mechanical gyroscopes/sensors. A critical O&S issue is repair costs over the lifetime of the hardware, the FOG has no mechanical parts, no gas leakage, and low power consumption in comparison with the mechanical sensors. The FOGs which are solid-state devices have lifetimes that are not size dependent and are predicted to last over the 100,000 hour category. Small RLGs have very limited operating lifetimes (several hundred hours). Another issue involves low leak rates, which are insignificant for large RLGs, but causes serious shelf-life problems for the small units. On balance, if thermal compensation techniques can be identified to improve the performance reliability over a military temperature range, the FOG is definitely a less costly device than RLGs and mechanical rotation rate sensors.

A96-173 TITLE: Wide Span Structures Using Pressurized Airbeams

CATEGORY: Exploratory Development

OBJECTIVE: Explore the structural dynamics and methods of achieving adequate stiffness using inflatable airbeam structures for wide span shelters of 60 feet or more.

DESCRIPTION: Inflatable structures result in significant weight, cube and deployment time savings over currently used metal frame supported structures. Recent advances in pressurized airbeam technology has focused on advancing manufacturing

techniques to enable reliable, durable and affordable construction. The technology is promising, however, to date it has focused on structures approximately 30 feet wide. There exists a need in both the military and commercial sector for wide span structures of 60 feet or more, particularly for fixed wing aircraft. This effort will focus on the structural aspects of achieving adequate stiffness for wide spans using inflatable members.

PHASE I: Define the structural characteristics of the selected inflatable airbeam construction. Identify the airbeam configuration required to meet the structural requirements of a wide span shelter. Demonstrate technical feasibility of the proposed configuration using small scale or full scale prototypes.

PHASE II: Work will focus on refining the phase I structural model and fabrication and testing of full scale prototypes of wide span inflatable airbeam structures.

POTENTIAL COMMERCIAL MARKET: Wide span inflatable structures have wide reaching commercial applications such as disaster relief, humanitarian relief, stadiums, and aircraft maintenance/protection.

OPERATING AND SUPPORT COST REDUCTION: There exists a need in both the military and commercial sector for lightweight, quickly erectable, wide span structures of 60 feet or more, particularly for fixed wing aircraft. This effort will explore the structural dynamics and methods of achieving adequate stiffness using inflatable airbeam arches for wide span shelters. Inflatable airbeam structures result in significant weight, cube and deployment time savings over currently used metal frame supported structures. Savings in operational and support costs will be achieved through reduced transportation, manpower, and labor hour requirements. The advancement of inflatable technology could also result in additional operational and support cost savings if the technology is exploited for other military applications such as mobile floating platforms, antennas or high glide deployable wings.

A96-174 TITLE: Rapid Inflation Systems for Inflatable Structures

CATEGORY: Exploratory Development

OBJECTIVE: Explore techniques of rapidly inflating high pressure inflated airbeam structures.

DESCRIPTION: The Army is developing a rapidly deployable shelter capability using high pressure inflatable airbeams for structural support. This new manufacturing technology will have improved reliability, durability and producibility over current commercial inflatable technology. Off-the-shelf inflation systems (consisting of blowers and compressors) for these shelters remain unacceptably heavy, expensive and slow.

PHASE I: Explore alternative techniques (such as a chemically activated inflation system) to deploy an airbeam supported maintenance shelter in less than 30 minutes. Assume there are 10 inflatable arches, each 13 inches in diameter, 60 feet long and inflated to 65 pounds per square inch. Identify the most promising technique and demonstrate the technical feasibility of the concept using a small scale prototype system.

PHASE II: Refine the Phase I design, fabricate and test a full scale inflation system prototype.

POTENTIAL COMMERCIAL MARKET: Inflatable structures have wide reaching commercial applications such as disaster and humanitarian relief shelters, aircraft escape slides, mobile floating platforms, inflatable antennae, and flood control.

OPERATING AND SUPPORT COST REDUCTION: The Army is developing a rapidly deployable shelter capability using high pressure inflatable airbeams for structural support. Off-the-shelf inflation systems (consisting of blowers and compressors) for these shelters remain unacceptably heavy, expensive and slow. The objective of this effort is to explore techniques of rapidly inflating high pressure airbeam structures. This new technology will reduce operational and support costs by replacing larger and heavier existing systems (reducing transportation costs) and reducing the manpower and labor hours required for deployment. Additional savings could be achieved through dual use of these rapidly inflatable structures for applications such as disaster and humanitarian relief shelters, aircraft escape slides, mobile floating platforms, inflatable antennae and flood control.

A96-175 TITLE: Diesel Fuel Preheater

CATEGORY: Exploratory Development

OBJECTIVE: To develop a metal-hydride preheater for diesel burners.

DESCRIPTION: The DoD conversion of combat vehicles from gasoline to diesel and JP8 has resulted in a persistent problem in similarly converting vaporizing burners to conform to this new fuel standard. A catalytic vaporizer has been developed that has demonstrated the ability to convert diesel fuel into lighter hydrocarbons, enabling the burner to operate with a blue flame that is indistinguishable from a gas burner. However, preheating the vaporizer to achieve initial vaporization of the diesel needs improvement Conventional air aspirated preheaters (blow torches) impinge a flame on the outside of the vaporizer to vaporize the fuel (<350C) prior to catalysis. They are inefficient, consume a large volume of air (that is physically added to the tanks with a hand pump), and require preheating outside the kitchen because of the noxious smoke and fuel vapor produced. An alternative to the exterior blow torch is an internal exothermic chemical heater. Metal-hydride systems have been successfully developed for automotive catalytic converters to lower emissions to ULEV standards. These systems are small and inexpensive, and reach a temperature of 400C in less than 5 seconds. They are regenerated by the vehicle exhaust (500C). The heat output, rate, and temperatures are within the operating parameters of a preheater for a diesel burner. Accordingly, the objective is to develop a metal-hydride preheater for a diesel burner to enable smokeless preheating inside the field kitchen.

PHASE I: Conduct a study to establish the feasibility of this approach that includes, but is not limited to: the design and fabrication of an experimental preheater that provides baseline performance data; identification of source bed materials, testing of the materials; and integration of the preheater within a vaporizer.

PHASE II: Design, fabricate, and demonstrate an optimized integral preheater capable of smokeless ignition of a diesel burner. Fabricate and deliver 10 prototype units.

POTENTIAL COMMERCIAL MARKET: Multifuel lanterns, burners, and heaters used for disaster relief emergencies, remote areas, third world countries, recreation, recreation vehicles (vans and yachts).

OPERATING AND SUPPORT COST REDUCTION: The M2 gasoline burner is the standard heat source used in field feeding. The current field feeding plan is to convert from gasoline to diesel cells for the replacement of the M2 with an advanced powered diesel/JP8 burner. The availability of a low cost diesel conversion kit consisting of a metal hydride preheater in combination with a catalytic vaporizer would respond to the conversion of operational fuels while extending the life of M2s allowing for a more gradual, cost saving, transition to powered burners. It also provides an option to remain with diesel M2s in selected situations e.g., for situations where no field generators are available.

A96-176 TITLE: Non-system Training devices and Training Instrumentation Systems/Technology Advancements

CATEGORY: Exploratory Development

OBJECTIVE: To develop new and innovative solutions specific to Program Manager, Training Devices problem/issue areas.

DESCRIPTION: The PM TRADE's mission is to plan, control, coordinate, and manage the development, acquisition, and fielding of effective training systems for use by the United States Army, other services, and designated foreign and domestic clients. Also, it manage's the development, acquisition and fielding of instrumentation systems for the Combat Training Centers (CTC), Training Devices, Simulations, Simulators (TDSS) and Tactical Engagement Simulators (TES) for use during force-on-force training exercises. To be able to continue that mission into the 21st century, PM TRADE has identified the following areas for research and development investigation. Potential offerors may submit proposals for any or all the areas.

a. Numerous vehicular accidents have occurred during Army night field training exercises and experiments involving drivers wearing night vision image intensification devices. Subsequent night driving experiments conducted by the Dismounted Battlespace Lab have indicated the accidents are probably caused by perceptual problems experienced by the driver wearing the night vision image intensification device. Evidence indicates that a driver's night driving performance improves dramatically with experience. Therefore, there is the need for an innovative low cost high performance interactive Night Driving Simulator (NDS) concept. The envisioned concept should have "classroom and recreation room" modes of operations.

b. Existing combat engineering and construction equipment training simulators are typically not physics-based. Reasons for this include the computational burden of physics based calculations, the lack of optimized algorithms for such simulations, and simulators, such as crane-operation and driving simulators, that lack realistic behavior thus significantly reducing training effectiveness. Recent advances in computational methods and power, such as parallel processing and higher CPU rates, as well as improved visualization techniques, now make physics-based training simulators of this type a feasible reality. The need exists to develop a simulator capability which incorporates new methods for physics based virtual simulations for combat engineering and construction applications. These methods will provide more realistic simulator behavior and will allow for the efficient

determination of forces imparted on equipment due to static and dynamic loads, and will support instantaneous feedback to the trainee.

c. The Army/DOD needs a low cost "small foot print" electrical energy replacement for the BA5590 LiSO2 battery. The BA5590 operates a dismounted troop training instrumentation gear for about 24 hours. Training sessions typically lasts about a week and the expense of changing batteries every one or two days is great. The BA5590 is considered to be too heavy and too bulky. The desired electrical energy device will not pose any hazards to the soldier or the environment and operate in all weather conditions for at least 5 times as long as a BA5590 and should be flexible or small enough to not interfere with a soldier's movements.

d. The current MILES standard PMT S004 for Tactical Engagement Simulation (TES) supports up to 37 weapons platforms with 4 ammunition types each. Dismounted infantry is limited to 2640 BLUFOR and 2640 OPFOR players. Future missions envisioned could exceed the current standard's capability and could seriously limit the effective implementation of future TES exercises. Therefore, either a new and innovative TES concept or TES standard is needed to accommodate significantly increased numbers of players and weapon/ammunition types. Any new concept or standard must be downward compatible.

e. Current TES exercises as "played" at the combat training centers emulate many of the current direct-fire and indirect fire weapons via the use of basic MILES and SAWE/MILES II equipment/instrumentation. Many new weapon systems (e.g. laser based systems) and some contemporary weapon systems (e.g. the MK 19 grenade launcher, fire and forget weapons, and audio-video/IR/active-radar guided munitions) do not seem to be compatible with the basic MILES and SAWE/MILES II TES paradigm. A new and innovative TES based approach is needed to overcome these problems.

f. Realistic tactical proficiency training for intelligence collection operators require the simulated communications traffic be provided to operators in the language of interest. The current method of creating training communication scenarios in the foreign language is a time consuming and cumbersome process of integrating prerecorded segments of conversation into a meaningful whole. Moreover, the resulting product is frequently less than natural sounding. Therefore, there is the perceived need for a system that will produce a unlimited natural spoken output in a specified language which in its totality becomes the desired training communication scenario. The unlimited natural spoken output (or text output) from the envisioned system is the last phase of a near real-time transformation process which began with either a natural spoken or text input. The input language and output language will generally be different and selectible but for the proposes of this research American English is assumed to be the input language while the output languages for the initial demonstration should be two significantly different languages such as Swedish and Japanese. This language transformation process will be an integral part of the envisioned system. Other relevant parts include but are not limited to an effective man-system input/output interface, and array of productive tools to support scenario creation and manipulation, storing and retrieval of information, and visualization tools. Such a set of capabilities are envisioned for the next generation of Intelligence and Electronic Warfare Tactical Proficiency Trainers (IEWTPT). The next generation IEWTPT will allow an individual operator, or a number of operators and intelligence platforms, to interact with dynamic simulations in real-time. It will provide a good representation of speech in the target language and retain the intonation, inflection and emphasis of the speaker. It will be capable of supporting the specialized vocabulary of military operations, the addition of new words, the handling untranslatable words, and the altering of vocal characteristics.

g. There has been an increasing interest in long wavelength optical sources for various commercial and military applications, the later including both tracking and ranging. A number of practically viable military systems have been developed, in particular, accurate rangefinders as well as target designator and illuminators. A key component of such systems is a laser source whose wavelength falls within the regions of minimum atmospheric absorption (3-5um and 8-12um) that is matched with the reception band of the photo detector. The availability of such sources makes it possible to detect targets through storms and in an obscure environment. There are a number of requirements to be met in developing these sources. First, the pulse repetition rate should correlate with Multiple Integrated Laser Engagement System (MILES). Second, the output power level should be low enough to satisfy eye-safety requirements ANSI STD, Class 3A. Third, the wavelength of the source should be in an eye-safe spectral region. In this connection, NdYAG lasers which have received the most widespread use are not optimal although some techniques, in particular, Raman shifting in methane vapor or doping YAG with Er, can result in a laser operating in the eye-safe near IR spectral region. Currently, long wavelength sources based on nonlinear interactions in ferroelectric crystals (LiNb03, LiTa03, KTP, etc.) are reveling great potential for use in the aforementioned systems. In these sources, efficient generation of radiation in the wavelength range 2.5-4um can be obtained by using quasi-phase-matching techniques to compensate for the walk-off between the phase velocities of the pump wave (delivered by a powerful diode laser emitting around 0.8um) and the generated long wavelength radiation.

PHASE I: Explore concepts design possibilities in the above subject areas; develop concepts for each of the relevant design possibilities: and show the feasibility for concepts developed.

PHASE II: Taking the results of Phase I, take the most promising concept, design, or approach and develop and demonstrate.

POTENTIAL COMMERCIAL MARKET: The proposed developments would have application in many commercial environments (i.e. communications, entertainment, language training, any system needing self-contained power source, eyesafe laser rangefinder for automobile and construction industries).

OPERATING AND SUPPORT COST REDUCTION: 1) the development of a low cost driver perceptual trainer for night driving with night vision "goggles" is intended to significantly increase driver performance and reduce costly accidents, 2) the development of advance engineering models of combat engineering and construction engineering equipment and their interactions with their work environments so as to support increased equipment operator performance and more cost effective operations, and 3) the development of a low "small foot print" energy replacement for the BA5590 LiSO2 battery which would significantly reduce the O&S costs associated with operations at the Combat Training Centers (Ft. Irwin, CA, Ft. Polk, LA, & Holenfels, Germany)

A96-177 TITLE: Advancements in Instrumentation Technology for Documentation Systems/Technology Advancements for Threat Targets, Threat Simulation

CATEGORY: Exploratory Development

OBJECTIVE: To develop new and innovative solutions to a set of specific problems/technical Issues of interest to the Project Manager for Instrumentation, Threat Targets & Threat Simulators.

DESCRIPTION: PM ITTS's mission includes managing research, development, design, acquisition, fielding, modification and capability accounting of targets (aerial and ground), threat simulators and major (high cost and complex) instrumentation required for U.S. Army technical and operational test and evaluation. In additional, the PM is responsible for the live segment of the synthetic environment and the implementation of Distributed Interactive Simulation (DIS) to Army test and evaluation. In order to effectively execute this mission now and into the 21st century, PM ITTS has identified the following areas for research and development investigation. Potential offerors may submit proposals for any or all the areas.

a. Existing power generation techniques for powering simulators, data collection systems and instrumentation in field conditions require sophisticated air filtration and cooling systems to operate. Current systems are a noise hazard, use oil and fuels which are hazardous to the environment and pollute the air. Dust environments encountered in the field inflict a great deal of damage on turbine and internal combustion engine powered electrical power generation equipment. The development and maintenance costs of air filtration and cooling systems capable of operating in field environments is extremely high. What is needed is a quiet low maintenance hydrogen fuel cell power generation capability in the 5kw to 50 kw range which has minimal impact on the environment.

b. Since the LAN market is driven by commercial applications, existing LAN equipment has been primarily developed for only low power, limited range, stationary, point-to-point applications. As threat simulators move into the area of modern networking multimedia and Distributive Interactive Simulation (DIS) technologies, the use of real time, wireless networking of threat simulators in a developmental and operational test (i.e. Fort Hunter Liggett, CA) environment is critical. In the expected test environment, A LAN system would have to be able to operate between entities over a 8-10 km range, while overcoming several challenges. The challenges in this area are extended range, terrain masking, rugged environment, mobility, data communication bandwidth and frequency band conflicts with other LAN equipment. A system which can meet these challenges would push Threat Simulators to a whole new level of performance and functionality. Areas which would be explored in this research include: selectable dual bands (900/1200 Mhz) to allow flexibility, higher power output for longer range, omni-directional antennas for broader coverage, product huggardization for harsh environments, and increased data bandwidth for multimedia and DIS applications.

c. Currently, Command, Control and Communications (C3) threat simulations performance does not track manned threat performance well. Specifically, they have a particular difficulty in identifying and recognizing targets. Although the holistic man-machine level of performance is beyond the state-of-the art there are good reasons to believe that the innovative

application/adaptation of neural networks and fuzzy logic technologies to the Army's Modular Semi- Automated Force structure might prove to be an effective area to pursue. This research should, whenever possible, incorporate the results of cutting edge research and off-the-shelf-technology, and be compatible with threat simulator hardware.

d. The virtual reality world is quickly evolving and being applied to many DOD and industry scenarios. To optimize effectiveness of virtual reality, all human senses should be involved. Tactile feedback is one way to fulfill the sense of touch. There are several haptic interface devices currently on the market, however most are not capable of satisfying multiple tasks or being reconfigured for vastly diverse tasks. This research is envisioned supporting the virtual testing of weapon and vehicular systems and should focus on the design and demonstration of a feasible ergonomically sound reconfigurable haptic interface system. The initial virtual testing environment would need to adapt the haptic interface for a steering wheel, joystick, gas/brake pedal, knob/switch, needle/scissor and keyhole feedback.

PHASE I: Explore alternative concepts and develop feasible approach.

PHASE II: Implement the best approach from Phase I with the objective of demonstrating the feasibility and effectiveness of the concept.

POTENTIAL COMMERCIAL MARKET: The proposed developments would have far reaching applications in a number of commercial markets such as transportation, portable electrical power generation, mobile data communications, sporting events and video games.

OPERATING AND SUPPORT COST REDUCTION: This topic includes several sub-topical areas which directly contribute to the "Reduction of Operation & Support Costs" to the Army to include: 1) the development of low foot print power generation source in the 5kw to 50kw range to support training and system testing, 2) the development of an extended range LAN (local area network) for use in system testing intended to significantly reduce the O&S range costs, and 3) the development of an advance threat models to act as surrogates for "manned" threats intended to significantly reduce cost the of weapon system testing.

A96-178 TITLE: <u>Cooling Enhancements for Radiators</u>

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this effort is to design, fabricate and test an enhanced cooling technique for military vehicle radiator applications that allows for a more compact, lightweight, and lower cost radiator.

DESCRIPTION: Anticipate a future need for an advanced radiator that is more compact, efficient, and lighter weight than the current radiators while maintaining equivalent performance. Increases in engine horsepower in turn lead to increase in heat rejection requirements. The current Army doctrine of combat vehicles with smaller silhouettes leads to smaller under-armor space. In addition, the current radiators require a high percentage of the engine power to drive fans in order to achieve the necessary airflow for the already cramped radiator. To reduce weight of the radiator one approach might be to use lighter weight material such as aluminum. To increase the overall heat transfer coefficient, in-tube enhancements which cause mass transfer from the flow core to the tube wall, can be implemented thereby causing an increase in overall heat transfer coefficient. Such enhancements are deem desirable for a lightweight, compact, high performance radiator. Also, the concept design presented shall be consistent with army initiatives to reduce operating and support costs.

PHASE I: In Phase I, the contractor would develop a concept for the advanced radiator implementing such enhancements and perform testing of that concept in the laboratory. The concept and testing shall be documented in sufficient detail to allow the government to determine if it will satisfy the requirements for the future military application and provide the desired improvements mentioned above.

PHASE II: In Phase II, the contractor shall fabricate and test a prototype of the advanced radiator with such enhancements. the following items shall be deliverable under this effort: design drawings, test report, final report and a vehicle worthy prototype radiator.

POTENTIAL COMMERCIAL MARKET: Advancements can be implemented on fleet vehicles such as taxis, commuter buses, police cars, ambulances, fire trucks, or other vehicle exposed to rough field usage. The benefit of this technology would allow for more reliable heavy duty fleet vehicles.

OPERATING AND SUPPORT COST REDUCTION: This technology could lead to a reduced operating and support (O&S) cost for any vehicles exposed to rough field usage.

A96-179 TITLE: Reducing Army Operating and Support Costs

OBJECTIVE: Identify and develop innovative process or end-item improvements which may yield significant savings in the operation and support of Army equipment.

DESCRIPTION: The U.S. Army spends more than half of its overall budget, directly or indirectly, on the operation and support (O&S) of equipment ranging from small generators to large, sophisticated weapon systems. O&S costs cover a broad spectrum of items including spare/repair parts, fuels, lubricants, and the facilities and people involved in training operators and mechanics.

O&S represents a major opportunity for savings, and the Army is seeking ways to reduce these costs as part of a broad Acquisition Reform Initiative which will ensure a ready and viable warfighting force as the Army's buying power continues to decline. To this end, the Army has implemented the Operating and Support Cost Reduction (OSCR) Program to identify and develop cost savings initiatives. The Army SBIR Program, recognizing OSCR's importance, is soliciting innovative proposals which address the broad spectrum of OSCR applications.

This topic is broad by design to allow submission of topics which do not fit under other OSCR-related topics which are more specific in nature. Firms are encouraged to submit ideas which address any items of equipment, and which fall anywhere within the life cycle of an item. A past example of a successful OSCR initiative is a gun tube exerciser for tanks. This system provides a means of exercising gun tubes on tanks stored in Army depots. The gun tube exerciser significantly reduces the amount of time needed to exercise gun tubes. Other examples include innovations which reduce power or fuel consumption, increase battery life, facilitate maintenance tasks (or require them less often), and a multitude of other ideas which will save money in the operation of Army systems. Please note that the above examples are not intended to focus offerors on specific equipment or specific OSCR applications.

PHASE I: Identify techniques/processes or design applications to be implemented, and conduct all necessary research to demonstrate the feasibility of the proposed idea(s). This effort would include any modeling efforts required to estimate the expected O&S cost savings resulting from implementation of the concept.

PHASE II: Develop the techniques, processes, or applications identified in Phase I. This effort should result in a finished product which can be delivered to the Army and further marketed (in Phase III) by the small business.

POTENTIAL COMMERCIAL MARKET: OSCR applications nearly always have a direct application in related private industries. For example, the heavy trucking, construction, and mining industries would directly benefit from OSCR successes designed for Army wheeled and tracked vehicles. The airline and rotary wing industries would benefit from helicopter and unmanned aerial vehicle OSCR applications. Additional direct commercial applications exist for communications equipment, generators, and most other Army items of equipment.

NAVY
Proposal Submission

The responsibility for the implementation, administration and management of the Navy SBIR program is with the Office of Naval Research (ONR). The Navy SBIR Program Manager is Mr. Vincent D. Schaper. Inquiries of a general nature may be brought to the Navy SBIR Program Manager's attention and should be addressed to:

Office of Naval Research
ATTN: Mr. Vincent D. Schaper
ONR 362 SBIR
800 North Quincy Street
Arlington, VA 22217-5660
(703) 696-8528

The Navy's SBIR program is a mission-oriented program which integrates the needs and requirements of the Navy primarily through science and technology dual-use, critical technology topics. A total of 31 Science and Technology (S&T) areas has been identified (see Table 1). While all of these areas may not be funded equally during the annual DOD SBIR solicitations in which the Navy participates, topics will be funded according to a priority it has established to meet its mission goals and responsibilities.

PROPOSAL SUBMISSION:

The Navy WILL NOT ACCEPT THE RED FORMS in the rear of the book as valid proposal submission. There are only two ways of submitting your SBIR proposals to the Navy. You may send a disk to the Navy SBIR Program Office at the above with a single hard copy of the exact proposal that is on the disk; or you may access the Navy SBIR Bulletin Board and submit your proposal via the Internet and send a single hard copy of the exact proposal that you send via the Internet.

FOR PC with WINDOWS:
SUBMITTING a DISK and ONE HARD SIGNED COPY OF YOUR PROPOSAL:
The Navy's part of the solicitation which is readable and retrievable from the INTERNET under the ONR Homepage (address--http://www.onr.navy.mil) contains topics which permit small businesses to submit their solutions to Navy requirements. We are providing proposers the opportunity to send proposals on diskette or via the Internet for this solicitation. From the ONR Homepage on the INTERNET you may gain access to the Navy SBIR Bulletin Board by clicking on BUSINESS OPPORTUNITIES and then on Navy SBIR Bulletin Board or by accessing it directly at address - http://web.fie.com/web/fed/onr/down/onrdn.013.htm. Once on the Bulletin Board go to 96.2 Solicitation and down load the text, forms and compression files into your computer. Make sure you READ the "readme" file. This informs you about submitting your proposal to the Navy using your PC computer with WINDOWS capability and for filling out your SBIR proposal on disk (Appendix A, B, C, and proposal text) which can be mailed to the above address together with a single signed hard copy. All proposals sent on disk should be written using one of the following software packages: WordPerfect 5.1, 5.2, 6.0; WordStar 2000 1.0, 2000 2.0, 2000 3.0, 3.3, 3.4, 4.0, 5.0, 6.0, 7.0; MultiMate 4.0; MS Word for Windows 1.0 or 2.0; MS Word 4.0, 5.0 or 6.0; or Display Write 4.0 or 5.0. You may ask technical questions through the SBIR Interactive Topic Information System (SITIS), see Section 7.2 of this solicitation. A listing of companies selected for award negotiations for this Navy SBIR solicitation will be listed on the INTERNET on the Navy SBIR Bulletin Board. If you do not have Internet capability, the same

information can be obtained by sending a request letter for a Navy SBIR disk together with a typed self addressed adhesive label and then submitting your proposal on disk with a signed hard copy of your proposal.

FOR WINDOWS AND MAC USERS:
SUBMITTING YOUR PROPOSAL VIA INTERNET with ONE HARD SIGNED COPY;
Submitting your proposal via Internet is the proposers responsibility....THERE IS A RISK OF INTERCEPTION. However, it affords you the opportunity to submit your proposal if you were not aware of the solicitation and had only limited time to make a submission or had a Macintosh Computer and had no ability to use or rent a PC with Windows capability. This mechanism for submission will be closed exactly at 2:00 Eastern Standard Time on the date noted in section 6.2 of the front portion (DOD section) of this solicitation.
To submit your proposal via the Internet follow the instructions on the Navy SBIR Bulletin Board (address noted above) under the section entitled "Submit your Navy SBIR Proposal". You will send your proposal using a file named with the three initials of the principal investigator (your first, middle and sur name.....if you don't have a middle initial use "Z"), your month and day of birth and numeral representing the number of that proposal which is being submitted for that topic. For example, Mary Jane Jones is submitting her second proposal under topic N96-100 and she was born on 10/18/68. The proposal she would send would have the file name MJJ10182.
If you are using Windows you may use any of the software packages noted above. If you are using a Macintosh you must use a Microsoft Word that can be converted into the PC version.
Once you have sent your proposal using the Internet you must send to the address noted above .....A ***SINGLE HARD COPY OF THE EXACT PROPOSAL YOU SENT ON THE INTERNET AND IT MUST BE RECEIVED WITHIN FOUR (4) WORKING DAYS AFTER THE OFFICIAL CLOSING DATE NOTED IN PARAGRAPH 6.2 OF THE DOD SECTION OF THE SOLICITATION.***

This solicitation contains a mix of topics. When preparing your proposal keep in mind that Phase I should address the feasibility of the solution to the topic. Be sure that you clearly identify the topic your proposal is addressing. Phase II is the demonstration of the technology that was found feasible in Phase I. Only those Phase I awardees which have been invited to submit a Phase II proposal by the Navy technical point of contact (TPOC) during or at the end of successful Phase I effort will be eligible to participate for a Phase II award. If you have been invited to submit a Phase II proposal by the Navy TPOC get a copy of the Phase II Instructions from the Navy SBIR Bulletin Board on the Internet. All Phase I and Phase II proposals should be sent to the Navy SBIR Program Office (at the above address) for proper processing. Phase III efforts should also be reported to the SBIR program office noted above.

The Navy will provide potential awardees the opportunity to reduce the gap between Phases I & II if they provide a $70,000 maximum feasibility Phase I proposal and a fully costed, well defined ($30,000 maximum) Phase I Option to the Phase I. <u>The Navy will not award Phase I contracts in excess of $70,000 (exclusive of the Phase I option).</u> The Phase I Option should be the initiation of the demonstration phase of the SBIR project (i.e. initial part of Phase II). The Navy will also offer a "fast track" into Phase II to those companies that successfully obtain third party cash partnership funds ("fast track" is described in Section 4.5 of this solicitation). When you submit a Phase II proposal it should consist of three elements: 1) a $600,000 maximum demonstration phase of the SBIR project (i.e. Phase II); 2) a transition or marketing plan (formally called "a commercialization plan") describing how, to whom and at what stage you will market your technology to the government <u>and</u> private sector; 3) a Phase II Option ($150,000 maximum) which would be a fully costed and well defined section describing a test and evaluation plan or further R&D if the transition plan is evaluated as being successful. While Phase I proposals with the

option will adhere to the 25 page limit (section 3.3), Phase II proposals together with the Phase II option will be limited to 40 pages. The transition plan should be in a separate document.

Evaluation of proposals to the Navy will be accomplished using scientific review criteria. Evaluation and selection of Phase I proposals will be based upon technical merit and other criteria as discussed in this solicitation document. Due to limited funding, the Navy reserves the right to limit awards under any topic and only proposals considered to be of superior quality will be funded.

TABLE 1. NAVY MISSION CRITICAL SCIENCE AND TECHNOLOGY AREAS

TECHNOLOGY	SCIENCE
Aerospace Propulsion and Power	Computer Sciences
Aerospace Vehicles	Mathematics
Chemical and Biological Defense	Cognitive and Neural Sciences
Command, Control, and Communications	Biology and Medicine
Computers	Terrestrial Sciences
Conventional Weapons	Atmospheric and Space Science
Electron Devices	Ocean Science
Electronic Warfare	Chemistry
Environmental Quality and Civil Engineering	Physics
Human-System Interfaces	Electronics
Manpower and Personnel	Materials
Materials and Structures	Mechanics
Medical	Environmental Science
Sensors	Manufacturing Science
Surface/Undersurface Vehicles	
Software	
Training Systems	

NAVY SBIR PROGRAM MANAGERS OR POINTS OF CONTACT FOR TOPICS

TOPIC NUMBERS	POINT OF CONTACT	PHONE
144-176, 289	Mr. Douglas Harry	703-696-4286
177-186	Mr. Joseph Johnson	703-784-4801
187, 194 208-210, 215, 216, 222, 226-228, 232, 234, 238	Ms. Cathy Nodgaard	703-604-2437 x6309
190-193, 195, 196, 199-207, 211-213, 229	Ms. Carol Van Wyk	215-441-2375
188, 189,197, 218-221, 230	Mr. Walt Kahl	301-826-7870
198, 217	Mr. Chuck Sullivan	317-306-7998
223-225	Mr. Peter (Pete) O'Donnell	908-323-7566
239-244, 284	Mr. Eugene (Gene) Patno	805-989-9209
214, 231, 233	Ms. Janet Wisenford	407-380-8276
246-247, 249-259	Ms. Betty Geesey	703-602-6901
282	Ms. Patricia Schaefer	703-767-6263
235-237, 263, 264, 280, 283	Mr. Donald Wilson	301-394-1279
248	Ms. Louise Goodman	619-553-2104
245, 285, 288	Mr. Jack Griffin	203-440-4116
260-262, 265-279, 281, 286, 287	Mr. Bill Degentesh	703-602-3005

DEPARTMENT of NAVY
Small Business Innovation Research (SBIR) Program
96.2 Solicitation Topic Titles

OFFICE of NAVAL RESEARCH

N96-144 TITLE: Engineering Technologies for Large Complex Systems

N96-145 TITLE: System Engineering of Human Resources and Cognitive Task Analysis in Complex Navy Systems

N96-146 TITLE: Vertical-Cavity Surface-Emitting Laser

N96-147 TITLE: Dielectric Materials for Use with Wide Bandgap Semiconductors

N96-148 TITLE: Photonic Technology for RF, Microwave, and mmW Antennas

N96-149 TITLE: Ultra-High Isolation Circulator/Duplexer for Surveillance and Communication

N96-150 TITLE: Four Dimensional (4-D) Atmospheric and Oceanographic Instrumentation

N96-151 TITLE: Radar and Electro-optical Analysis Tool

N96-152 TITLE: Low-Cost, Covert, Moored Environmental Monitoring Package

N96-153 TITLE: Acoustic Clutter Discrimination and Classification

N96-154 TITLE: Fuel Cells for Underwater Vehicle Propulsion

N96-155 TITLE: Thin Film Thermoelectric Device Science & Technology

N96-156 TITLE: Advanced Polymer Optical Fibers

N96-157 TITLE: Flame Resistant Organic Composites

N96-158 TITLE: Alternative Curing Technology For Composites and Adhesive Bond Processing

N96-159 TITLE: Improved method for the production of difluoramine energetics

N96-160 TITLE: Production of Strained Liquid Hydrocarbon Fuels

N96-161 TITLE: Quiet, Compact, Efficient Variable Ballast (VB) System for Small Undersea Vehicles

N96-162 TITLE: Micro-Actuators and -Sensors based on Terfenol-D Film

N96-163 TITLE: Nonlinear Dynamics Control of Advanced Electrical Power Systems

N96-164 TITLE: Expert System for Underwater Vehicle Maneuvering Control

N96-165 TITLE: Low Profile Motion Sensor

N96-166 TITLE: Laser Scanning Three Dimensional Surface Velocity Vibrometer

N96-167 TITLE: Container for Storing and Processing Injectable Carbon Dioxide-Containing Fluids and Freeze-Dried Blood Components

N96-168 TITLE: Biological Neural Network Software Toolkit

N96-169 TITLE: Smart Analog Vision Chip with Spatio-temporal Filtering

N96-170 TITLE: Novelty Detection for Condition-based Maintenance of Mechanical Systems Using Neural Networks

N96-171 TITLE: Operation Evaluation of Advanced Integrated Air Vehicle Suites

N96-172 TITLE: Incorporation of Gap Effects in the Design of High Performance Missile Control Fins

N96-173 TITLE: Superconductor Applications to Aircraft Electric Systems

N96-174 TITLE: Model Development for Shock-Induced Reactions in Non-Explosive Materials

N96-175 TITLE: Microscopic Investigation of Rocket Propellant Processing Parameters on Cure Shrinking

N96-176 TITLE: Rapid Positioners for Precision Manufacturing

MARINE CORP SYSTEMS COMMAND

N96-177 TITLE: Composite Mine Vehicle Survivability Kit

N96-178 TITLE: Anti-Personnel Obstacle (APOBS) Breaching System Manufacturing Technology

N96-179 TITLE: Battlefield Information Warfare

N96-180 TITLE: Deployable Power Distribution System

N96-181 TITLE: Multipurpose Lifting/Excavating Arm

N96-182 TITLE: TRSS Air Delivered Target Acquisition Sensors

N96-183 TITLE: Knowledge-based System

N96-184 TITLE: Ultra-WideBand Antenna

N96-185 TITLE: Detection of Unexploded Ordnance (UXO)

N96-186 TITLE: State of Charge Monitoring for Hybrid Electric Vehicles

NAVAL AIR SYSTEMS TEAM

N96-187 TITLE: Fretting and Wear Resistant Blade/Vane Coatings

N96-188 TITLE: Multivariable Integrator Windup Protection for Aircraft Fight Control System using Model Predictive Controller

N96-189 TITLE: Development of a High Power Air-Cooled Clutch

N96-190 TITLE: Viscous Cartesian Unstructured Grid Generation

N96-191 TITLE: High Lift Aerodynamics Shear Layer Transition Modeling

N96-192 TITLE: Aircraft Weapon Bay Turbulent Flow Simulation Model

N96-193 TITLE: SYSTEMS ENGINEERING ENVIRONMENT: Methods and Tools for Collaborative Systems Engineering at Geographically Distributed Sites

N96-194 TITLE: Innovative Control Design Impact for Aircraft

N96-195 TITLE: Escape System Data Recorder

N96-196 TITLE: Hot Film Sensing of Vortex Shedding and Structural Dynamics

N96-197 TITLE: Advanced Scanning Interferometer System for Characterization of Moving Surfaces.

N96-198 TITLE: Wire Bonding Interconnects for High Temperature Silicon Carbide Electronics

N96-199 TITLE: System and Algorithm Concepts for Automatic Detection and Classification of Non-Traditional Acoustic Signals

N96-200 TITLE: Integrated Flight Performance Model for Various Aircraft Platforms

N96-201 TITLE: Using Multi-media for embedded Training within Application Software

N96-202 TITLE: A POSIX Interface for the F-22 Common Integrated Processor Avionics Operating System

N96-203 TITLE: Incremental Modernization of Legacy Software Systems(IMLSS)

N96-204 TITLE: Transitioning Embedded Avionics Software from Ada 83 to Ada 95

N96-205 TITLE: Adaptive Optics for Advanced Laser Systems

N96-206 TITLE: Laser Beamrider Detection

N96-207 TITLE: High Brightness, Wavelength Selectable, Pulsed Solid-State Laser Sources.

N96-208 TITLE: Unmanned Aerial Vehicle(UAV) Low Probability of Intercept (LPI) Communications Relay and Interrogator for the Search and Rescue Beacon Transponder

N96-209 TITLE: Unmanned Aerial Vehicle(UAV) Based Magnetic Anomaly Detection (MAD) for Small Submarine Hunting in Shallow Water and Over-the-Land Reconnaissance

N96-210 TITLE: Optical Beam Forming Network

N96-211 TITLE: Ytterbium Yttrium Orth-Vanadate (Yb^{3+}:YVO_4) Laser Crystals

N96-212 TITLE: Corrected Fiber Optic Laser Beam Delivery

N96-213 TITLE: Engineered Infrared Nonlinear Optical Materials

N96-214 TITLE: Image Matrix Merger

N96-215 TITLE: Innovative Methods for Minimization Glass Bead Abrasive Blasting Hazardous Waste Stream

N96-216 TITLE: Single Component Sealant for Watertight Integrity and Corrosion Control

N96-217 TITLE: Optical Time Domain Reflectometer Development

N96-218 TITLE: Fiber Optic Microwave Transmission System

N96-219 TITLE: High Frequency Lossy Line Extension

N96-220 TITLE: Faster High Intensity Radiated Fields (HIRF) Testing from 10 Khz to 40 Ghz

N96-221 TITLE: Electronic Maintenance of Equipment Identification and Configuration Data

N96-222 TITLE: Advance Model-Based Reasoning

N96-223 TITLE: Improved Visual Landing Aids on Air Capable Ships

N96-224 TITLE: Piloted Approach Decision Aid Logic (PADAL) System

N96-225 TITLE: Hydrogen Fuel Cell for Powering Aviation Support Equipment.

N96-226 TITLE: Fuel Bladder Cell Failure Identification

N96-227 TITLE: Determine the State of State of Stress in Non-Ferromagnetic Metals and Composite Structures.

N96-228 TITLE: Comprehensive Electrical Evaluation of Polyalphaolefin Dielectric Coolant

N96-229 TITLE: Open Systems to Legacy Systems Communications Bridge

N96-230 TITLE: Design Assistant for Application of System Identification and Adaptive Control to Aircraft Flight Systems

N96-231 TITLE: Image Generator Frame to Frame Update Post Processor

N96-232 TITLE: Enhanced/Operator Machine Interface

N96-233 TITLE: Trade-Off Techniques for Training Using Multimedia

N96-234 TITLE: Improved Missile Positioning, Attitude Sensing and Targeting (IMPAST) Using the Global Positioning System (GPS)

N96-235 TITLE: Optimal Resource Allocation in a Distributed Computing Environment.

N96-236 TITLE: Enhanced Target Movement Prediction.

N96-237 TITLE: Object Recognition and Tracking at Video Rates

N96-238 TITLE: More Effective Employment of Precision Guided Missiles (PGMs) with the inclusion of Weather Data

N96-239 TITLE: New Polymeric Material for Propulsion Systems

N96-240 TITLE: GPS Based Formation Control

N96-241 TITLE: Interdigital Deposition of Highly Conducting Polymers for Electrochromic Window Application

N96-242 TITLE: Ability to Predict Scene Based Algorithm/System Performance

N96-243 TITLE: Improve Thermal Shock Resistance of Sapphire

N96-244 TITLE: Nanometer Metal Powder Production

SPACE and NAVAL WARFARE SYSTEMS COMMAND

N96-245 TITLE: UHF-SHF Flat Panel (Planar) Antenna Arrays

N96-246 TITLE: Electro-Optics Window for Shipboard Application

N96-247 TITLE: Enchanced Infrared Images of Pop-up Targets

N96-248 TITLE: All-Software Global Positioning System (GPS) Receiver

N96-249 TITLE: High Resolution Time-Frequency Representations

N96-250 TITLE: Automatic Feature Combined Track-Detect-Localize Technique

N96-251 TITLE: Passive Acoustic Transient Detection and Analysis of Mine Operations

N96-252 TITLE: Development of Performance and Traffic Adaptive Management Tool for High Performance Communications Networks

N96-253 TITLE: Requirements Management Assistant

N96-254 TITLE: Image Information Preserving Compression for LOFARGRAMs

N96-255 TITLE: Image Compression for LOFARGRAMs

N96-256 TITLE: A Mission Planning Trainer Module for IUSS Deployable Systems

N96-257 TITLE: Adaptive Beamforming for Littoral Waters

N96-258 TITLE: Robust Coding Scheme for Satellites (ROCSS)

N96-259 TITLE: Dynamic Selection of Reallocated Timeslots

NAVAL SEA SYSTEMS COMMAND

N96-260 TITLE: Virtual Prototyping

N96-261 TITLE: Oceanic Environmental Control

N96-262 TITLE: Advanced Technology Information Interconnectivity

N96-263 TITLE: Fast Room Temperature Cure Adhesives for Fiber Optic Connectors

N96-264 TITLE: Develop Techniques for Use of Open System Architectures for Commercial Off-the-Shelf-Components

N96-265 TITLE: Three Dimensional Target Location from Video Images

N96-266 TITLE: Develop Uplink Channels Within Military GPS Receivers

N96-267 TITLE: Electronically Stabilized and Deblurred Camera

N96-268 TITLE: Innovative Gun, Chamber, Breech Designs

N96-269 TITLE: Very Low Structure Borne Noise Unit Enclosure for COTS Modules

N96-270 TITLE: Generic Electronic Card Chassis & Power Supply Enclosure

N96-271 TITLE: Core Based ASIC Signal Processor

N96-272 TITLE: Expanded Data Link Throughput for Submarines

N96-273 TITLE: Interactive Acoustic Analysis Processor

N96-274 TITLE: Signal Processing Platform-Independent Code Generation from Software Specifications

N96-275 TITLE: Mine Localization and Registration

N96-276 TITLE: Plastic/Elastomeric Sensor Outer Heads/Housings

N96-277 TITLE: Advanced Spatial Filtering

N96-278 TITLE: Technology Infusion Methodology for COTS-based Systems

N96-279 TITLE: Low Light Level Color Imaging with Image Processing (readvertised)

N96-280 TITLE: Integrated Fuzzy Control Systems for Missiles

N96-281 TITLE: A High Doppler IR Target

N96-282 TITLE: Electronic Support (ES)-Radar Track Correlation

N96-283 TITLE: Thin Cell Thermal Battery

N96-284 TITLE: Advanced Hot Gas Valve and Manifold Technologies for Shipboard Missiles

N96-285 TITLE: Smart Sensor Technology for Sonar Systems

N96-286 TITLE: Innovative Broadband Transducer Technologies

N96-287 TITLE: Passive Processing Technology

N96-288 TITLE: Improved Undersea Towing Cable

N96-289 TITLE: Affordable, Low Energy, Nanoscale Transistorless Static RAM

DEPARTMENT of NAVY
SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
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NAVY SMALL BUSINESS INNOVATION RESEARCH PROGRAM
96.2 SOLICITATION TOPIC DESCRIPTIONS

OFFICE of NAVAL RESEARCH

N96-144 TITLE: Engineering Technologies for Large Complex Systems

OBJECTIVE: The objective of this topic is to improve the capability to develop and assess complex computer-based systems. Specifically, this topic relates to the description of methods, processes, and development product models and tools required to engineer large complex systems.

DESCRIPTION: Technologies to be investigated include, but are not limited to (1) process modeling, (2) virtual prototyping, and (3) simulation.

Process modeling technology is a topic of active research in the software engineering community. However, the engineering of complex computer systems places additional requirements on process modeling technology. Among the additional requirements are: timely feedback across disciplines and organizational boundaries; evolutionary requirements and open interfaces to accommodate new requirements and technology options; integration of heterogeneous tools as well as legacy systems and data bases; representation of the complex systems engineering process at multiple levels of abstraction and from multiple perspectives. Innovative approaches are sought to extend existing process modeling technology to address the real needs of complex computer systems.

Advances in computer simulation and visualization technology provide a unique opportunity to develop Virtual Prototyping technology for the engineering of complex computer systems. In the context of system engineering, Virtual Prototyping refers to the application of Virtual Reality (VR) technology to systems engineering activities. The vision is to be able to create and exercise prototypes that engage developers and users via visualization and sensory immersion. Such prototypes must be a faithful representation of the system under development and allow decisions to be made regarding development alternatives and tradeoffs. Areas which show promise relate to activities associated with the general area of "system evaluation and assessment."

The ability to synthesize evaluation results from various domains (e.g., functional and implementation) and to trade-off between multiple candidate design options such that key design issues within the context of the overall system design is crucial. Simulation techniques have been effectively used in assessing system designs. However, simulation models today are very expensive to build. With the existence of requirement and design data repositories, it is important to have the ability to automatically or semi-automatically generate different executable computer models.

PHASE I: Define a simulation based design concept, virtual prototype, and/or process model that supports the design and development of complex, computer based systems. Demonstrate the feasibility of the concept through prototype analysis of a sample Navy problem.

PHASE II: Develop an automated toolset that supports the simulation based design concept, process model, and/or virtual prototype and demonstrate its capabilities.

PHASE III: Transition methods and tools into standalone product applicable to current Navy development programs. Commercialize.

COMMERCIAL POTENTIAL: Applicable to large-sized, complex, computer based system including banking, traffic control, and communication, and military systems.

REFERENCES:

1. Curtis, B., Kellner, M. I., and Over, J., Process Modeling, Communications of the ACM, vol. 35, no. 9, pp. 7590, September 1992.

2. N. Karangelen and N. Hoang, "Simulation Based Design for Large
Complex Computer Based Systems", Pro. Systems Engineering of Computer-Based Systems Workshop, IEEE Computer Society Press, Los Alamitos, CA, 1994, pp 116-123

3. Jons, Otto P.,J. Christopher Ryan, and Gary W. Jones, “Using Virtual Environments in the Design of Ships,” Naval Engineers Journal, May 1994.

N96-145 TITLE: System Engineering of Human Resources and Cognitive Task Analysis in Complex Navy Systems

OBJECTIVE: The objective of this topic is to obtain systems-engineering methods and tools to improve human integration and human-machine function allocation in complex systems. This research will also assist in the assessment of the human roles in the operation of Navy's ship systems. The developed method(s) and toolset are used to identify the system's functions that can be automated and the trade-off between man and machine in term of performance as well as cost. The method must also addresses the effect of the manning reduction in the organization structure.

DESCRIPTION: Naval ship systems, including surface ships and submarines, are normally operated and maintained by large group of crew members. Facing the new challenges, the fluctuation and non-determinism of the operational environment, and the reduction in defense budget, Navy's ships must be cost effective and perform better to cope with multiple unexpected scenarios and changing environments. Automation of human functions on ships must be carefully planned and evaluated throughout the design process and should provide optimal use of the total system. Method(s) defined within this research should show a system engineering approach where human operator is a part of the basic and implementation design. The method(s) must provide the capability to represent a wide range of human resources (from an individual operator to a complex organization structure), to characterize the human resources in a format that can support various type of analysis, and must address different evaluation techniques to assess the human role in the operation of the total ship. The methods should explicitly integrate the human, hardware, and software elements operating in dynamic and uncertain environments. Complexity can be optimized and integration between the human and other system elements can be improved by analyzing the cognitive demands, making appropriate design adjustments early in the design process, and by establishing design methods to address human operators and decision makers as adaptive elements in operational system designs. Tools should incorporate biologically motivated measures of cognitive complexity and help designers assess the difficulty of system learning, predict performance changes under stress, and modify the design accordingly.

PHASE I: Develop a model to derive complexity measures from task descriptions, and formulate design recommendations to mitigate the complexity by optimizing interface layout and providing support in interface navigation and action planning. Validate the model with respect to a significant Navy system.

PHASE II: Using the model and validation results from Phase I, develop a prototype systems-engineering aid for cognitive task analysis and complexity measurement. Phase II work should include the full scale development of an automated tool. Usefulness of the methods and tool should be demonstrated on a sample test case to facilitate the transition of the work into Navy systems. The initial methodology report should be updated to incorporate the lessons learned during the development of the tool.

PHASE III: Apply tools developed to improve the design of a Navy System by assessing the difficulty of system learning and foreseeing the impact of stress on performance.

COMMERCIAL POTENTIAL: The largest market for this technology would be the designers of complex consumer products and industrial systems, such as transportation, telecommunication networks, process plants, and power stations. Application of the tools in the design process entails the ease-of-use and other advantages with respect to the competing products of similar functionality.

REFERENCES:
1. Yufik & Sheridan, 1995. "Assessment of cognitive complexity: Helping people to steer complex systems through uncertain and critical tasks." NASA Ames Research Center, Final Report NAS2-1370.
2. Karangelen, N., Hoang, N., Howell, S., "Representing System Resources in Design and Analysis of Complex System," Proc. Energy-Sources Technology Conference and Exhibition, Software Systems in Engineering Track, Jan 1994.

N96-146 TITLE: Vertical-Cavity Surface-Emitting Laser

OBJECTIVE: To produce an efficient vertical-cavity surface-emitting laser (VCSEL) that will operate in a spatially stable, single frequency mode.

DESCRIPTION: VCSELs have shown great promise as low cost singlefrequency sources for communications and spectroscopy. This is due to the inherent single longitudinal mode that exists in a short cavity VCSEL. Multiple lateral modes have resulted in more than a single frequency during operation of the devices. Currently, single-frequency devices can be made using techniques such as optical apertures on implanted structures. Many of these single-frequency devices rely on large optical losses, that result in single-frequency devices that have reduced efficiencies. Other methods rely on thermal lensing to define the optical

mode, and this results in a bias dependent beam waist. For applications requiring external optics for the collimation of the light from the laser, it is preferable to have a well defined optical mode. The purpose of the investigation is therefore to produce highly-efficient VCSELs that operate in a single frequency with a spatially stable mode.

PHASE I: Demonstrate the fundamental technologies necessary to produce efficient, single frequency VCSELs. Design efficient, spatially stable, single-frequency VCSELs and show how the design improvements can be used for visible and IR VCSELs.

PHASE II: Produce single frequency VCSELs and demonstrate the single frequency and the stability of the optical mode under dynamically varying operating conditions, such as temperature and large signal modulation. This should be performed using at least two different material systems, demonstrating VCSELs operating at different frequencies.

PHASE III: Develop reliable single frequency VCSEL arrays applicable for laser printers and fiber communication systems.

COMMERCIAL POTENTIAL: Single frequency VCSEL arrays that operate with a stable optical mode will be used in the next generation of high performance laser printers. The devices are also applicable for low cost environmental spectroscopy and single-mode fiber communication systems.

REFERENCE: F.M. Peters, G.D. Robinson, M.G. Peters, D.B. Young, and L.A. Coldren, "Small Electrically Pumped Index-Guided Vertical Cavity Lasers," IEE Photonics Tech. Letters, 6, (10), 1176-1181 (October 1994).

N96-147 TITLE: Dielectric Materials for Use with Wide Bandgap Semiconductors

OBJECTIVE: Develop new high temperature, high dielectric-strength insulating materials for use with wide bandgap semiconductor materials.

DESCRIPTION: New approaches have shown that wide bandgap (e.g., > 2 eV) semiconductors exhibiting significant improvements in thermal conductivity, dielectric strength, and charge carrier velocity may now be synthesized with purities approaching that in silicon. New insulating materials are sought for use as gate and field dielectrics in devices employing these wide band gap semiconductors in order to enable optimal device performance that will greatly exceed that of currently used silicon-based power devices. The full realization of this potential requires the development of new higher performance dielectrics that are more robust and can operate at higher temperature than silicon dioxide.

PHASE I: Demonstrate an insulating layer which when used as a passivating gate-dielectric with SiC or GaN permits the control of at least a factor of two more charge in the underlying semiconductor at the same value of gate voltage than would be possible with silicon dioxide as the gate insulator.

PHASE II: Demonstrate improved performance of the new dielectric over silicon dioxide in a wide-bandgap device operating at least 400C.

PHASE III: Demonstrate a power switching device (fabricated from the new dielectric and SiC or GaN) exhibiting at least 10 times the power handling capacity of a Si device of the same dimensions which will support the Navy's Power Electronics Building Blocks Program.

COMMERCIALIZATION POTENTIAL: New systems using this technology will handle power more efficiently, thereby wasting less power and lowering pollution. This capability will enable several new systems advances including replacement of vacuum tube microwave amplifiers with solid-state components, replacement of fire-prone hydraulic systems in aircraft with electrically actuated systems (more-electric aircraft), and all-electric vehicles.

REFERENCES:
1. Matus, L. G., Powell, J. A., and Salupo, C. S.,¢High Voltage 6H-SiC p-n Junction Diodes¢, Appl. Phys. Lett. 59, pp.1770-2 (1991)
2. B. J. Baliga, "New Materials beyond Silicon for Power Devices"
in "Power Semiconductor Devices and Circuits", Ed. by A. A. Jaecklin, Plenum Press, New York, pp. 377-388, (1992).

N96-148 TITLE: Photonic Technology for RF, Microwave, and mmW Antennas

OBJECTIVE: Develop photonic technology and optoelectronic systems that enable future Navy C3I systems based on multi-function antenna systems.

DESCRIPTION: The effective utilization of photonic technology and systems provides the DOD with new options for the cost-effective implementation of multi-function RF/Microwave/millimeter wave antennas (MFA). Future MFA systems will need to operate over multiple radar/communications bands, be able to accommodate wide instantaneous signal bandwidths and be able to simultaneously form multiple frequency independent beams. Platform constraints will generally limit the size, weight and distribution of the antenna feed network and beam forming processor. Realization of this capability provides opportunities for a variety of innovative applications of photonic technology and system concepts. Examples of relevant topics include, but are not limited to the following: photonically controlled antenna elements, reconfigurable antennas, adaptive beam forming, optical fiber links, and related devices and components such as rapidly tunable lasers and spectral filters, wideband modulators, etc. Proposals that exploit the speed/bandwidth of photonic technology or the inherent parallelism of optoelectronic processors, and address component, device or systems issues relevant to MFA, as described above, will be considered.

PHASE I: Investigation of proposed concept; identification of innovation and discussion of technical issues. If necessary, a laboratory demonstration proving feasibility of concept or resolution of controversial issue.

PHASE II: Design of prototype; demonstration of concept with prototype system; discussion of all relevant performance issues and production or manufacturing issues;

PHASE III: Evaluation, modification and optimization of prototype within context of a Navy operational environment as provided by a suitable Navy System Command or Navy laboratory. Funding to be obtained by proposer from non-SBIR government funds or from commercial sponsors.

COMMERCIAL POTENTIAL: The wideband technology components and systems developed for this program have numerous dual-use commercial opportunities within the high-speed telecommunications, satellite communications and digital multimedia distribution markets.

REFERENCES:

1. IEEE Transactions on Microwave Theory and Techniques, Vol. 43, No. 9, (Special Issue on Microwave and Millimeter Wave Photonics), September 95.
2. IEEE Transactions on Antennas and Propagation, Vol. 43, No. 9, (Special Issue on Packaging Technologies for Phased Array Applications), September 95.
3. Optical Techniques on Microwave Applications VIII, SPIE Vol. 2560, 11-12 July 95, San Diego, CA
4. Proceedings of Photonic Systems for Antenna Applications, (ARPA Symposium), 18-20 Jan 95, Naval Postgraduate School, Monterey, CA.
5. Optoelectronic Signal Processing for Phased-Array Antennas IV, SPIE Vol. 2155, 26-27 January, Los Angeles CA.
6. Symposium on Optical Microwave Systems using Fiber Optics, 1994 Technical Digest Series, OFC 94, Vol. 4, Optical Society of America.

N96-149 TITLE: Ultra-High Isolation Circulator/Duplexer for Surveillance and Communication

OBJECTIVE: The objective of this effort is to develop the best approach to obtain more than 75 Db of isolation in a UHF (200 to 400 Mhz) M port circulator/duplexer. Other performance criteria include low insertion loss (3 Db) and 60 dBm peak power handling capability for transmit and receive applications.

DESCRIPTION: The Navy has constraints in its ability to add new antenna systems to its ships due to the proliferation of antennas currently adorning their topside real estate. One solution to this problem is to combine shipboard systems to utilize a single antenna aperture thereby reducing the number of antennas required and making space available for new ones. To do this Ultra-High Isolation Circulators/Duplexers, exceeding 120 Db, need to be available to achieve the required isolation between transmit and receive functions as well as between systems. This problem is currently referred to as Electromagnetic Interference (EMI) and our goal is to obtain Electromagnetic Compatibility (EMC) between collocated systems.

PHASE I: This part of the investigation will entail defining the problem and assessing the current state of isolator technology in Active (solid state), Passive (ferrite), and Emerging (cancellation) technologies that will lead to solutions. Further, an initial design and demonstration of the isolation properties of the successful approach, and a prototype design of a three port Ultra-High Isolation Circulator/Duplexer, should be addressed.

PHASE II: This part of the investigation will entail transitioning the successful isolation technology to a two-port isolator, a three port circulator, and an M port circulator which meet the program specifications and packaging requirements for both Military and Commercial applications.

PHASE III: The successful devices from Phase II will be transitioned into a Navy Advanced Technology Demonstration.

COMMERCIAL POTENTIAL: The commercial sector will make use of ultra-high isolation circulators in the automobile and communications industries. A specific example of an application would be to combine functions such as global positioning, personal (cellular) communications, and intelligent vehicle highway system functions into a single wideband aperture mounted on/in the roof of a vehicle. These systems will be coming to automobiles by the year 2000 and the need for this technology to be identified in order to obtain the required system performance.

REFERENCES: Lockhart, Douglas K., Microwave Circulator Design, Artech House, Norwood MA; ISBN/ISSN: 089006329X; LCCN: 89-6550; OCLC: 19456097

N96-150 TITLE: Four Dimensional (4-D) Atmospheric and Oceanographic Instrumentation

OBJECTIVE: Develop low-weight and small-volume systems to autonomously measure atmospheric and/or oceanographic parameters.

DESCRIPTION: Innovative sensors and measurement techniques are solicited to obtain marine atmospheric and oceanographic variables (e.g., physical, chemical, optical, geophysical, biological and acoustic) in 3-D space and time. The emphasis must be placed on (1) novel approaches and concepts for measuring a particular parameter(s) coherently in 4-D; (2) conducting these observations as autonomously as possible; i.e., for independent operation on Remotely Piloted Aircraft (RPA), Unmanned Under Vehicles (UUVs), or Buoys; and (3) provide a significant reduction in instrument weight and volume without reducing fidelity or resolution as compared to current state-of-the-art systems. The instruments solicited can utilize either active and/or passive measurement approaches. Full column depth capabilities are desired in instrumentation planned for subsurface use. Proposals can focus on one or more of the following Top level needs:

1. Measure atmospheric turbulence to resolutions of a few centimeters a second utilizing a GPS based approach;
2. Measure water vapor (in and out of cloud) to provide high fidelity and resolution measurements;
3. Obtain vertical profiles of ocean current, temperature, salinity, and sound velocity throughout the water column on scales of the order of 1 meter per second;
4. Measure temperature, salinity, pressure in the water column with resolution adequate to address issues of microscale mixing and ocean turbulence;
5. Measure upward and downward solar and terrestrial broad band radiation to include important windows and absorption wavelength bands to quantify the presence and radiative impact of aerosols, water vapor (measure the vertical and horizontal variability), and ozone;
6. Measure aerosol spatial distributions with an eye safe airborne lidar;
7. Measure cloud properties to provide high fidelity and resolution of extension parameters and cloud physics (covering the widest possible droplet size distributions);
8. Measure small scale turbulent fluxes of heat mass and momentum through out the water column;
9. Measure the acoustic properties of the water column, surface and bottom boundary layers, and the bottom sediments; and/or
10. Improve accuracy and precision of underwater navigation.

PHASE I: Provide both an exact description of the parameter to be measured include accuracy and coherence along with the design concept for achieving the measurement.

PHASE II: Produce a viable system and demonstrate it's ability to support in field measurements from an operating autonomous research vehicle.

PHASE III: Transition the technology to scientists in the atmospheric, oceanographic and environmental monitoring research communities, and operational DOD systems.

COMMERCIAL POTENTIAL: New instruments can be used in commercial environmental monitoring systems.

N96-151 TITLE: Radar and Electro-optical Analysis Tool

OBJECTIVE: Develop a system to enable calculation of electro-magnetic (EM) and electro-optical (EO) sensor system performance characteristics.

DESCRIPTION: Innovative techniques are solicited to develop a work-station based analysis tool to facilitate analysis of CW,

pulsed Doppler, coherent pulsed, and non-coherent pulsed radar's. The system shall calculate basic radar performance characteristics; plot vertical coverage diagrams; calculate beamwidths, sidelobe levels and beam patterns for parabolic phased (periodic and aperiodic) and frequency steered array antennas; calculate moving target indicator (MTI) response curves; and calculate and plot ambiguity functions. The system shall include environmental effects such as rain, fog and ducting conditions on radar signal propagation. It will also include the effects of signal degradation due to electronic means and physical jamming such as the release of chaff and aerosols. In addition, the system will accept input of antenna edge taper or more precise antenna calculations.

The system shall also include electro-optical systems analysis capability. It will determine the maximum range at which an input electro-optical system would be able to detect a verity of ship and aircraft targets in different environments and with various backgrounds. The model must work over a spectrum from approximately .01 to 14 microns and should contain modules for targets, atmospherics, various backgrounds, and electro-optical system characteristics.

The primary objective for the EM/EO analysis tool is to support a general assessment of sensor systems where some specific system characteristics maybe unknown. The analysis tool shall facilitate the determination of sensor performance through utilization of fast modeling runs that allow for quick variation in sensor characteristics and performance (some sensor compotes may be parametrized). Each model run should cover a specific spectrum of parametrized environmental, ECM and target and background characteristics. Modeling results require only a basic out-put of sensor performance to allow the assessment of system trends or variation in the threshold of detection based on component performance. Utilization of existing models or algorithms is strongly supported.

PHASE I: Establish the framework for implementation of this effort, establish the criteria and methodologies that will be used, and document and describe, in detail, how the system will be designed and implemented.

PHASE II: Develop a system and validate by test and evaluation using novice and experienced EM/EO system analysts and engineers. The system must be user friendly, have clearly defined fields and be able to provide an output with limited input detail. The system will provide measurements of error based on accuracy of the input values. Deliver and demonstrate the final product with detailed manuals.

PHASE III: The EM/EO model solicited here is likely to transition to DoD users of EM/EO analysis tools for system assessments. Variations of the model developed could support intelligence, engineering, and tactical assessments of various EM/EO systems configurations in varying environments.

COMMERCIAL POTENTIAL: EM/EO analysis tool could support cost to performance analysis of developmental sensor systems to aid in early system engineering decision making. Radar and EO designers and users will find this system as a useful analysis tool.

REFERENCES:
1. Blake, L.V., "A Guide to Basic Pulse-Radar Maximum Range Calculation," Part 2, NRL Report 7010, December 1969
2. Blake, L.V.,"A Fortran Computer Program to Calculate the Range of a Pulse Radar," NRL Report 7448, August 1972
3. Fielding, J.E., and Reynolds, G.D., "VCCALC: Vertical Coverage Calculation Software and User's Manual," Artech House, 1988; and
4. White Paper: Radar Analysis Workstation, Radian Corporation.

N96-152 TITLE: <u>Low-Cost, Covert, Moored Environmental Monitoring Package</u>

OBJECTIVE: The objective is the development of a practical, low cost, self-deploying fixed environmental monitoring system for shallow water which is not readily detectable during or after deployment and which returns data in a covert or low profile manner.

DESCRIPTION: Fixed sensor packages are required to allow covert monitoring of environmental conditions in hostile or denied littoral regions to aid Naval Special Warfare, Amphibious Warfare, Mine Warfare and Mine Counter Measures, and Antisubmarine Warfare. These packages must be delivered in a covert or very low profile fashion, must not be readily detected while collecting data, must remain in a fixed, known location during collection, and must be able to return their data surreptitiously with little or no human intervention. Recovery must not be necessary. Desired environmental parameters include: temperature, sound speed, optical profiles, sea state/wave conditions, tidal parameters, ambient noise, current profiles. (Not all need be implemented on one unit.)

PHASE I: Prepare a detailed hardware, software, and communications concept, demonstrate the feasibility of the concept through assessment of the current maturity of necessary technologies and identification of critical issues and likely solution approaches, identify the work necessary for a Phase II effort necessary to demonstrate the concept, and increase the

likelihood of a Phase III transition through exploration of dual use potential.

PHASE II: At the end of a two year effort, fabricate and demonstrate several working prototypes that could be used as reliable instrumentation by other basic and exploratory development programs. The hardware, software and communications concepts should have been developed and demonstrated completely enough to transition to an active advanced development program, to become the basis for an operational requirement, and to be commercialized for private sector use. Deliver prototype units to Naval Research Laboratory for use in its Coastal Ocean Sensing and Data Fusion project.

PHASE III: Transition to advanced development, and commercialization as a low cost, low profile coastal oceanographic/water quality measurement system to areas of high shipping/boating traffic and other human activity.

COMMERCIAL POTENTIAL: Measurement of oceanographic and water quality parameters in coastal areas is hindered by high levels of human activity resulting in damage to and loss of expensive instrumentation. This system would be low profile enough that damage and theft would be minimized and low cost enough that loss would not be as economically serious as with present systems.

N96-153 TITLE: Acoustic Clutter Discrimination and Classification

OBJECTIVE: Develop discrimination techniques and methodologies to distinguish and classify bottom clutter and false targets from high resolution acoustic sonar systems as either natural (or environmental) or man-made objects on or near the bottom.

DESCRIPTION: High resolution acoustic sonars are being developed for Mine Countermeasures (MCM) with dramatic improvements in sonar signal and image quality and image resolution[1]. This requires equal increases in sonar signal processing and tends to increase the operator's workload. Clutter suppression is typically accomplished through averaging and thresholding so that low level peaks are not seen by the detection processor, thereby greatly reducing processing time and operator workload. However, thresholding is often indiscriminate when applied to a characteristic, such as received level and may eliminate a weak but desired signal. Clutter can both prevent mine detection as well as cause false targets that waste MCM resources. Clutter discrimination uses signal and image processing techniques to identify and classify clutter both before and after the detection processor. Clutter discriminators can be developed from various mathematical transforms as well as from existing statistical, fractal, chaotic, and texture theories. Discrimination provide a mechanism for distinguishing clutter and separating it into different classes. Clutter discriminators offer the possibility of finding mines within the clutter that would fall below the threshold of clutter suppression techniques and for determining adaptive thresholds for clutter suppression. They can be used on a ping-to-ping basis or in multiping correlation. Automated classification and discrimination of high resolution sonar clutter should reduce operator workload, reduce false target prosecution, and increase detection in highly reverberant environments.

Phase I. Explore methodologies and techniques from radar, medical, satellite, and side-scan signal and image processing that may be applied to high resolution acoustic sonar in order to characterize and classify clutter as natural (or environmental) vs man-made.

Phase II. Perform a trade off analysis of selected methodologies and techniques with existing high resolution signal returns and imagery including hardware requirements and computer workload.

Phase III. Implement and test clutter discrimination on a real-time high resolution sonar system.

COMMERCIAL POTENTIAL: This technology would have wide commercial application in the field of undersea mapping and charting as well as environmental assessments and cleanup in bays, lakes, and estuaries, mapping navigational hazards in commercial shipping lanes, and in oil and gas drilling operations and pipeline maintenance.

REFERENCES:

1. Ramsdale, Dan J., J. Stephen Stanic, Edgar T. Kennedy and Roger W. Meredith, "High Frequency Environmental Acoustics Research for Mine Countermeasures," Proceedings of the Symposium on Autonomous Vehicles and Mine Countermeasures, 4-7 April 1995.

2. Daniel F. Lott and Roger W. Meredith, "Mine Countermeasures Sonar Performance Models: Survey Results and Environmental Issues," SACLANTCEN Programme of Work.

N96-154 TITLE: Fuel Cells for Underwater Vehicle Propulsion

OBJECTIVE: Demonstrate the performance capability of fuel cells for underwater vehicle use.

DESCRIPTION: The silver oxide/zinc (AgO/Zn) battery is the Navy's workhorse power supply for driving a number of its underwater vehicles, like Swimmer Delivery Vehicles, Deep Submergence Rescue Vehicles, torpedoes and torpedo targets. For such use, AgO/Zn offers the highest energy density of any commercially available, high power rechargeable battery. However this energy density is still insufficient to power the run times needed by future vehicles. A hydrogen/oxygen fuel cell has over six times the theoretical energy density of AgO/Zn (1082 Wh/lb for the fuel cell operating at 0.8 V, versus 176 Wh/lb for Ag/Zn operating at 1.5 V). The object of this SBIR Topic is to bring closer to reality this potentially enormous superiority of fuel cells for increasing the range and speed of underwater vehicles.

PHASE I: Conduct a design analysis of fuel cell power supplies for underwater vehicle propulsion. Evaluate energy and power densities (both gravimetric and volumetric) as a function of the energy content and physical size (including all ancillary components) of the fuel cell. Detailed electrical and physical specifications for the power supplies of several targeted underwater vehicles will be provided, after contract award. The vehicles are cylindrically shaped and cover a size range (diameter x length) of from 18" x 81" to 4' x 20'.

PHASE II: Bench top demonstration of optimum fuel cell chemistry.

PHASE III: Application of scaled up in a vehicle demonstration.

COMMERCIAL POTENTIAL: Electric vehicles for civilian use.

N96-155 TITLE: Thin Film Thermoelectric Device Science & Technology

OBJECTIVE: The goal of this program is to develop thin film based thermoelectric devices and evaluate their potential for large area cooling or power generation.

DESCRIPTION: Thermoelectric (TE) materials offer a huge potential for a variety of heating and cooling applications. Current manufacturing techniques are based on the assembly of bulk TE modules. This topic seeks a new approach to the fabrication of TE devices based on thin film techniques. This is particularly important as advances in material performance (ZT) are likely to include superlattice engineering. The ability to fabricate functional thin film TE devices for a wide range of heating or cooling application is required. Navy cooling requirements can range from a few W (cooling electronic components) to Kw (shipboard AC) depending on application. In addition thermoelectric devices could be exploited for exhaust heat recovery for power generation from a number of Navy systems. Thin film TE technology offers the potential for low cost, light weight, high COP heating or cooling systems. However, the range of applications over which the thin film based technology is viable and the science & technology needed to prepare such devices requires further development and is the subject of this topic. Either physical or chemical deposition methods are envisioned for the fabrication of the thin film devices. Basic issues related to thin film deposition will be explored (i.e. substrate compatibility, growth temperatures, growth rates, etc.). Processes compatible with current semiconductor processing methods are desirable.

PHASE I: Phase I will develop a demonstration of a thin film based thermoelectric device and will develop models for incorporating these thin film devices into systems with specific cooling or power generation capabilities. Modeling of the TE devices will be an integral part of phase 1. The models developed in phase one will define limits to the cooling/heating output of these devices from a total system point of view and will provide designs to exploit the thin film devices for obtaining the highest cooling capacity or power generation capacity that is realistic.

PHASE II: This aspect of the program will focus on the details of making TE thin devices a viable commercial technology. Thin film growth efforts will address large area deposition and property/materials uniformity. Optimization of the deposition technique will be addressed. Appropriate device manufacturing issues will be addressed in phase II which include development of etching and masking technologies, device isolation, metallization (with specific emphasis on contact resistance issues), multi-staging, and heat sink integration. Modeling studies will focus on the details of employing large arrays of thin film TE devices for large scale applications. Integration of thin film arrays into an overall heating or cooling system will be of specific interest.

PHASE III: A prototype fabrication system will be designed for producing thin film devices on a large scale. factors associated with production cost and scale-up will be studied. Specific system designs for cooling or power generation will be available for a variety of heating and cooling applications.

COMMERCIAL POTENTIAL: The commercial potential of thermoelectric based technologies is enormous. Currently TE

technology is a critical component of the recreational cooler industry. Low cost passive cooling techniques are reaching their limits for current consumer electronics. It is anticipated that TE cooling technologies can play a major role in thermal management of microprocessors used in future generation computers, a tremendous market. From a power generation point of view, the ability to harness exhaust heat opens up an entire new set of applications and commercial interests ranging from enhanced automobile fuel economy to auxiliary power systems.

N96-156 TITLE: Advanced Polymer Optical Fibers

OBJECTIVE: Develop high performance polymer optical fibers (POFs) that can be used as generic device components in high-bandwidth systems.

DESCRIPTION: Optical fiber is used predominantly for information transmission, with high-bandwidth long-haul communications bing dominated by single-mode glass fiber. For *short-haul* applications, however, graded index polymer optical fibers have many advantages, including low cost, flexibility, and ease in making connectors. With the development of graded index POFs the bandwidth of these materials has exceeded the gigahertz-kilometer range which has significantly increased data transmission capacity. However, commercially available POFs have relatively low service temperatures, typically <80°C. Innovative techniques are sought for the development of both step-index and graded index POFs for high temperature applications. The performance of the developed materials should have comparable or better properties than that of the current commercial POFs. This work will include the technology for fabricating high quality waveguides in device materials, and may include the technology of making waveguiding fiber structures with optically nonlinear materials.

PHASE I: Demonstrate feasibility of the concept to prepare high performance step and graded index POFs. Develop a process to make reliable low loss single mode fiber with both single an dual cores. Characterize waveguiding properties and thermal and environmental stability. Demonstrate methods of coupling light between cores. Construct structures of nonlinear optical materials.

PHASE II: Fabricate materials into optical fibers and characterize properties. Build a prototype linear device such as a 3dB splitter in a single mode fiber with connectors. Demonstrate coupling to a single mode glass fiver and demonstrate thermal and environmental stability. Investigate methods of making active devices, such as optical switches.

PHASE III: Demonstrate compatibility of devices in local area network and transfer technology for commercialization. Demonstrate thermal and environmental stability in the working environment, e.g., simulated shipboard and air environments.

COMMERCIAL POTENTIAL: High temperature POFs will find a large market section in data communication systems in aircraft, ships and automobiles. Coupler devices can be used in local area networks, fiber to the home, computer data links, and connections between communications systems.

N96-157 TITLE: Flame Resistant Organic Composites

OBJECTIVE: To demonstrate structural organic composites with flame-hardened matrices.

DESCRIPTION: Currently, composites with organic matrices can not be applied in high temperature environments, and burn with the production of large quantities of smoke and toxic gases. There is a need for materials with elevated operating temperatures and with matrices which are difficult to ignite or are self-extinguishing, once ignited. New matrix or sizing chemistries to promote such behavior are required.

PHASE I: Demonstrate flame hardness or self-extinguishing capacity of organic matrices suitable for use in fiber-reinforced composites.

PHASE II: Scale-up matrix synthesis capability to produce quantities sufficient for processing fiber-reinforced composites. Produce sufficient quantities of composites for preliminary mechanical characterization.

PHASE III: Pilot-plant operation for production of flame-hardened organic composites.

COMMERCIAL POTENTIAL: Private sector applications will include safer materials for air and maritime transportation.

N96-158 TITLE: Alternative Curing Technology For Composites and Adhesive Bond Processing

OBJECTIVE: Develop Microwave/RF heating techniques for the processing of thermoplastic composites and adhesive bonds.

DESCRIPTION: One of the problems in applying thermoplastic composites and adhesive bonding technologies is the high temperatures required for processing and the issues with equipment and processing materials that is inherently related to this problem. One concept to eliminate these issues is the use of directed energy to heat only the polymer in the composite or the bondline. This would eliminate the need for high temperature bagging materials and sealants, high temperature tooling and processing equipment, and allow thermoplastic bonding to be used for low temperature substrates. This bonding could be accomplished through the use of microwave or RF energy, Many thermoplastics are inherently receptors for these types of energy and others can be compounded with receptors. In the case of adhesive bonding, just the bondline would be heated allowing thermoplastic bonding to be used on epoxy composite, aluminum bonds, or repairs. Further the bond could be easily be reheated and removed if desired thus providing a bond with the advantage of mechanical fastening.

PHASE I: Demonstrate the feasibility and physics understanding of various tuned frequency energies for consolidating thermoplastic composite laminates and for bonded panels.

PHASE II: Develop and demonstrate the capability to fabricate complex composite parts and bonded structures.

PHASE III: The successful products of this effort will transition to support of McDonnell Douglas aircraft programs and Navy aircraft repair activities.

COMMERCIAL POTENTIAL: Current efforts involve development of thermoplastic composites for rehabilitation equipment and devices (such as prosthetics, braces, wheelchairs, and lifting devices. Recreational products such as commercial aircraft, automotive, and mass transit have potential use for thermoplastics and bonding techniques

N96-159 TITLE: Improved method for the production of difluoramine energetics

OBJECTIVE: Development of an improved method for the introduction of the gem-difluoramine group in the synthesis of oxidizers that will contain difluoramine and nitramine groups.

DESCRIPTION: Oxidizers that contain mixed difluoramine and nitramine functionality are calculated to give significant performance enhancement as components in propellant and explosive applications. The current synthesis methods involve the use of harsh acid conditions and the generation of the very hazardous difluoramine gas. Alternate synthetic methods must be found for gem-difluoramine materials in order to exploit their use in energetic applications.

PHASE I: Exploration of new routes to gem-difluoramine compounds in gram quantities. Emphasis should be on synthetic methods that are safe and capable of being transitioned to pound level production. Reagents and conditions should be selective for introduction of the gem-difluoramine in high yield without the use of harsh conditions.

PHASE II: Development of the synthetic routes discovered in Phase I to further refine the processes for their use in multi-pound preparative reactions. The focus will be on achieving a practical and economical process for the production of these materials.

PHASE III: Scale-up the most efficient/safe route to produce quantities (> 100 pounds) that will allow the development and large-scale testing of formulations containing difluoramine compounds.

COMMERCIAL POTENTIAL: High energy propellants for commercial launch vehicles especially when weight and performance requirements are critical (for example, final stage rocket motors).The potential exists also for applications in the field of oil recovery. The industry needs very high performance explosives for the enhanced recovery of oil from mature fields. The process of rock fracturing could be considerably improved by the high metal accelerating ability of the NF2 explosives. The industry has already shown interest in CL-20 for this application, a Navy explosive whose performance is calculated to be less than that of NF2 compounds. The NF2 oxidizers offer the additional capability, in composite formulations with metals, of tailoring the output to maximize fracturing in various rock formations.

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N96-160 TITLE: Production of Strained Liquid Hydrocarbon Fuels

OBJECTIVE: Develop the methodology to produce large quantities of strained liquid hydrocarbon fuels, namely, substituted quadracyclines, alkyl substituted cubanes, and substituted benzvalenes.

DESCRIPTION: Increasing the range and speed of cruise missiles and ramjets and aircraft is an important Navy need. As increasing the combustion efficiency can provide only marginal increases in these parameters, a more desirable and logical approach is to increase the volumetric energy content of the fuel. An innovative way of obtaining this is to incorporate additional strain energy into the fuel molecules, during synthesis, by straining the molecular bonds, and closely packing the molecules. This project identifies three such classes of fuels indicated above. Primary focus will be on the production of nitro and azido quadracycline, azido dihydro benzvalene, and 1,4-dialkylated cubanes. Attention will be paid to reducing the number of steps in the synthesis process, using cheaper starting materials, using safe synthesis procedures, and ensuring purity.

PHASE I: Produce gram quantities of three target fuels: nitro and azido quadracycline, azido dihydro benzvalene, and 1,4-dialkylated cubanes.

PHASE II: In Phase II, scale-up criteria will be developed, and kilogram quantities of fuels from Phase I will be prepared for evaluation in combustion systems.

PHASE III: Of the fuel which emerges from Phase II as the superior fuel, one hundred to one thousand kilogram quantities will be produced, in the most economical way possible, in collaboration with a chemical manufacturer. (Eastman Chemical Co. has expressed interest).

COMMERCIAL POTENTIAL: Reduced number of steps in the synthesis process, cheaper raw materials, and large-scale production (as envisioned in this program) will lower the cost of the fuel. Because of the increased volumetric energy density of these fuels, the aircraft industry will benefit, particularly for use in long- range aircraft.

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N96-161 TITLE: Quiet, Compact, Efficient Variable Ballast (VB) System for Small Undersea Vehicles

OBJECTIVE: To develop a compact, quiet, and energy efficient a variable ballast (VB) system for use in Remotely Operated Vehicles (ROV) and Unmanned Undersea Vehicles (UUV).

DESCRIPTION: Current VB system used in ROVs and UUVs exceed the noise, volume, and energy requirements to meet the goals of future Navy missions. These system use state-of-the-art, high-pressure, positive-displacement pumps and valves. The pumps present a noise source that can not be adequately isolated for the sea within in the volume constraints for these small UUVs and ROVs. These pumps also represent a significant energy drain on long duration missions. The objective of this topic is to develop innovative ways to significantly reduce the pump noise, improve isolation, or totally eliminate the need for a high pressure pump, while simultaneously reducing system volume and energy requirements.

The Navy is seeking new, innovative, high risk/payoff ideas for compact, quiet, efficient VB systems. These ideas may include an innovative concept for entire VB system or innovative ways to reduce the noise, volume, or energy of existing conventional (pumping) VB systems. The ultimate goal is to develop ballast systems which operate to depth pressure in the range of 20-30 atmospheres (600-900 psig) and have differential buoyancy capacity on the order 20 kg. (44 lb.) in a total system volume of less than 85 liters (3.0 cu. ft.). If the system operates by moving seawater in and out of the vehicle it must be able to operate with the seawater inlet port at only 0.5 m (1.64 ft) below sea level.

PHASE I: At the end of a six month effort, work should have demonstrated the feasibility that the system concept can meet the ultimate goals stated above, identified critical subsystems or technologies that must be matured for transition into the Navy's acquisition system, outline the state of current technology maturity, provide evidence that the scientific principles on which the proposal was based are sound and justify further work, and identified the work necessary in Phase II effort to demonstrate the system concept for Navy applications.

PHASE II: At the end of a two year effort, technology or system concepts must have been developed enough to enable

critical subsystems or technologies to be transitioned to an advanced technology demonstration or into a higher category of RTD&E, or become the basis of a statement of need and acquisition for systems for a Navy application.

PHASE III: The Navy has identified the top three UUV Missions as mine reconnaissance, improved (long range) mine reconnaissance and surveillance. All of these missions required stealthy UUV systems that will transit through the density gradients between open oceans and littoral waters. These long range mission will also require surfacing for GPS navigational fixes. These requirements dictate the need for a quiet, compact VB system. Such a system will be transitioned to Navy UUV acquisition programs such as the Long Range Mine Reconnaissance System (LMRS) and could potentially support upgrades to the Near Term Mine Reconnaissance System (NMRS).

COMMERCIAL POTENTIAL: ROVs and UUVs are currently used for numerous commercial operations including oceanographic surveys, underwater inspection, and search and salvage operations. Many of these commercial missions require highly maneuverable neutrality buoyant vehicles. More compact and efficient systems are required to make UUVs and ROVs logistically and economically viable for commercial use. Commercially available sonars are becoming more sensitive. To gain the full commercial potential benefits of these sonars it will be required to reduced self-noise signature of the of the UUV and ROV platforms on which they are deployed.

N96-162 TITLE: Micro-Actuators and -Sensors based on Terfenol-D Film

OBJECTIVE: Development of adaptive composites magneto-elastic composite micro-sensors and actuators.

DESCRIPTION: Micro-actuators and -sensors utilizing giant magnetostrictive materials alone or in combination with others as thin film bi- or multi-morphs provide a promising basis for smart MEMS. Domain structure engineering may adapt the micro-system to a variety of applications such as high resolution magnetic field vector sensors and variable micro-actuators. Research and development is required to determine the possibilities and limits of domain engineering in giant magnetostrictive films in a variety of environments such as different substrates, modes of adhesion and resulting stresses. Successful development of micro-actuators and -sensors based on giant magnetostrictive materials will lead to novel and inexpensive environmental monitors and actuators for military, such as (flow control) and other non-military applications.

PHASE I: Define the basic concepts of adaptive structures utilizing magnetostrictive composites.

PHASE II: Produce and fully characterize magnetostrictive composites, develop a manufacturing process, fabricate prototypes of select composite micro-sensors and actuators and demonstrate their capabilities.

PHASE III: Demonstration of micro-device compass capabilities, for instance micro-compasses for ground positioning and guidance systems.

POTENTIAL COMMERCIAL MARKET: The micro-sensors have great potential as interactive monitors for magnetic and stress fields. The actuators can be integrated into aircraft meso-structures, ground transportation and engine management systems to enhance their capabilities.

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N96-163 TITLE: Nonlinear Dynamics Control of Advanced Electrical Power Systems

OBJECTIVE: Apply advanced mathematical tools to characterize the non-linear, time dependent nature of advanced electrical power system architectures. These tools will be fundamental to the control and management of the next generation submarine electric power systems.

DESCRIPTION: Navy needs of affordability, size reduction, high speed response and robust process control are leading to highly complex, solid state controlled power distribution systems. These systems will be highly non-linear, time, load and environmental dependent networks, with a large number of possible partially independent control points. Mathematics is to be demonstrated to provide efficient transient characteristics to be used for real-time, robust monitoring of central and distributed controls. Develop techniques for apportioning responsibility for control between central and distributed control. These characteristics shall be demonstrated useful in managing the power security of the network to be insensitive to load configurations.

PHASE I: Prove that specific advanced mathematical tools can extract characterizing features of power and control networks that are transient and load dependent.

PHASE II: Design a centralized and distributed controller for advanced power distribution system networks that allows the network to operate at maximum efficiency with energy bounds. Address how to apportion responsibility of centralized and local control.

PHASE III: Develop a software integrated to a hardware demonstration of an advanced solid state power distribution network, exhibit transient and load feature characterization transformers and control apportionment techniques developed in Phase I and Phase II.

COMMERCIAL APPLICATION: Solid State Power Distribution Control in more electric cars, aircraft and factory control systems.

N96-164 TITLE: Expert System for Underwater Vehicle Maneuvering Control

OBJECTIVE: Develop a knowledge based expert system to assist in submarine maneuvering and control operations.

DESCRIPTION: Knowledge based expert systems have in some instances been shown to have the capability to replace or assist human operators in controlling complex multi input/multi output systems. A maneuvering underwater vehicle is such a system. Multiple sensors can provide input on vehicle position, velocities, accelerations, environment, ballast, etc. Numerous control effectors are available including propulsor, rudder, control surfaces, thrusters, ballast movement, etc. Numerous operational requirements and constraints can exist; maximum pitch angle, desired track line, maximum roll, desired depth, recovery from various casualties, etc.

PHASE I: Develop and demonstrate an expert system for controlling an underwater vehicle. For a generic vehicle, with assumed but reasonable sensors, effectors, mission requirements and constraints deliver a working expert system prototype.

PHASE II: Develop such a system for a Navy specified vehicle. Include assessments of required sensor accuracy and required control forces to meet operational requirements. Document and deliver source computer code.

PHASE III: Provide the demonstrated system for future vehicles both Navy and commercial.

COMMERCIAL POTENTIAL: Many underwater vehicles both autonomous and remotely controlled could utilize this technology to improve performance.

N96-165 TITLE: Low Profile Motion Sensor

OBJECTIVE: Develop a cost effective, low profile, spatially distributed sensor which measures the motion of the surface to which it is attached.

DESCRIPTION: Pressure release coatings are used in the Navy to reduce the target strength and radiated noise on surface and submerged vessels. On a pressure release surface the velocity of an incoming acoustic wave doubles and its pressure goes to zero. Normal pressure sensing hydrophone arrays will not work at such a boundary condition. In order to measure the propagating acoustic field at a pressure release surface, the hydrophones have to be replaced with motion (displacement, velocity or acceleration) sensors. These sensors will be mounted on the pressure release coating and will be covered by a waterproof protective layer of rubber like material. The sensors should measure the motion perpendicular to the surface of the pressure release material and should be insensitive to the motions transverse to that plane. Since the sensor must be placed between the pressure release coating and the outer protective coating it should have minimum height in the direction perpendicular to the surface (less than 1 cm). The sensor should also match the density of the layer in which it is imbedded which is typically about 1.3 times as dense as sea water. In a typical application, the sensor must give the average motion of a square section of the pressure release coating. The averaging area will be related to the s dimensional array whose design frequency will vary

according to the particular array application. Since short wavelength noise mechanisms may be present the sensor should either continuously average the motion over that area or spatially sample that area effectively. The sensor should have an electronic noise floor lower than an equivalent output produced by a sea state 0 ambient acoustic field. The final requirement is that the motion sensor group be cost effective. There are existing sensors which can satisfy several of the above requirements but they are all prohibitively expensive when applied to sensing large areas.

PHASE I: Develop analytical model for candidate motion sensors attached to a pressure release surface. Predict electronic noise floor and determine spatial response and predict response for sensor group (if more than one sensor is used). Test basic principals of candidate sensors in the laboratory to document sensitivity as predicted by modeling. Estimate sensor cost in production quantities.

PHASE II: Select final sensor design and associated electronics. Fabricate prototype sensors and test for sensitivity, electronic noise floor, acoustic sensitivity on a pressure release material and operation while under pressure. Manufacture and test enough sensors to make 28 groups and acoustically test them as a line array.

PHASE III: Engineering development and full scale production. Marketing for commercial applications.

COMMERCIAL POTENTIAL: Low cost, low profile motion sensors would have commercial applications in smart skins being considered for airplanes and other high tech vehicles. The smart skins need to sense the forces and motions that they are subjected to in order to adjust their properties to those motions or forces present. The sensors would also prove to be useful in noise control applications where the sound level in either a air or water medium is to be controlled by active feedback.

N96-166 TITLE: Laser Scanning Three Dimensional Surface Velocity Vibrometer

OBJECTIVE: Develop Laser Doppler Vibrometer (LDV) using a scanning laser for three dimensional velocity field measurements on naval ships.

DESCRIPTION: Scanning laser vibrometry is presently used as a diagnostic tool for noise reduction in a number of industries but is limited to the measurement of out of plane vibrations. Existing laser vibrometers which measure three dimensional surface velocity obtain the in-plane vibrations using a dual beam optic head which must be very precisely positioned, The proposed approach will use computer controlled scanning mirrors to position the laser beam. The in-plane and out-of-plane coordinates of the surface vibration velocity will be obtained by scanning from a number of locations and then obtaining the three dimensional field using coordinate transform techniques. Using computer control and by scanning with the laser beam as compared to a mechanical positioning apparatus, it will be possible to quickly obtain the complex velocity of many surface locations.

PHASE I: Demonstrate system for measuring three dimensional velocity field on submerged structures. System should be capable of quickly measuring velocity spectra components smaller than one micrometer/sec for frequencies up to 10 Khz on both rigid and compliant structures.

PHASE II: Develop system for implementing the Laser Scanning Three Dimensional Surface Velocity Vibrometer for measurements on both full and large model scale static and underway conditions. Demonstrate approach for measurements on non-metallic structures as well as rotating components such as propulsors.

PHASE III: Configure the device into portable, computer controlled packages. Determine and implement user friendly post processing and imaging outputs required to optimize the device as a diagnostic tool for acoustic signature reduction applications.

COMMERCIAL POTENTIAL: Extending scanning laser Doppler vibrometry technology to the measurement of in-plane surface velocity will greatly increase its usefulness as a noise reduction diagnostic tool in the automotive and aerospace industries, since acoustic radiation and radiation control techniques are often associated with in-plane vibrations. A three dimensional system will be developed for an application where whole field, complex velocity response of structures would be of interest.

N96-167 TITLE: Container for Storing and Processing Injectable Carbon Dioxide-Containing Fluids and Freeze-Dried Blood Components

OBJECTIVE: To develop a light-weight container for preparing and storing injectable gas-containing fluids and freeze-dried blood components.

DESCRIPTION: A multicompartment container that is capable of storing injectable gas-containing fluids in one compartment

and is also capable of supporting the lyophilization of red blood cells and platelets under low temperatures and high vacuum conditions in a second compartment is required. The container should be composed of materials that are compatible with parenteral fluids, blood, and blood products, and which retain carbon dioxide at a concentration of at least 1.4 mM (45 mm Hg pressure) for more than 1 year. The container should be light weight, flexible, suitable for sterilization, and have sterile docking ports for loading, processing, mixing and transfusing the contained products. In addition, the container should have features that allow for uniform freezing and drying of the solid product and limit the exchange of ambient gases and water vapor after sealing.

PHASE I: The contractor should design a flexible container composed of sterilizable, pyrogen-free materials meeting the above criteria with the appropriate dimensions to maximize exposed surface area and minimize storage space.

PHASE II: Compatibility of the container with injectable fluids and lyophilization buffers and the low temperature/high vacuum lyophilization process should be continually assessed during this phase of development. Design and integration of the container with existing DoD/DoN support and logistics will be assessed during this phase. Submission of the device for approval by the FDA will be initiated.

PHASE III: Advanced development of system to reduce risks.

COMMERCIAL POTENTIAL: The commercial potential for this product is high. Parenteral fluids are under development employing carbon dioxide as part of a physiological buffering system, and these fluids will potentially replace currently employed parenteral fluids, millions of liters of which are used annually in trauma medicine and dialysis therapy. Lyophilized blood products, particularly platelets, may replace existing blood component storage modalities; millions of units of platelets and tens of millions of red cell units are used annually in trauma medicine and surgery.

N96-168 TITLE: Biological Neural Network Software Toolkit

OBJECTIVE: Develop a biological neural network toolkit to enable system developers and signal processing engineers to utilize state-of-the art neural architectures emerging from interdisciplinary research in biological neural networks for challenging pattern recognition and control applications.

DESCRIPTION: A number of novel biologically-inspired neural network architectures, many with Hebbian learning rules, have been developed and demonstrated on DoD applications in the past decade. These architectures have advantages in scaling, speed, hardware resource use, robust performance with noisy data and high capacity. Despite these advantages, these algorithms and architectures have not been as widely used in the commercial and defense sectors as artificial neural networks such as feedward nets with backpropagation of errors. This is largely due to the fact that the biological networks are often configured as stand-alone experimental tools for university research. There is a need for efficient, user-friendly versions of these biological networks to be made available to the wider engineering community, either as software packages, or as extensions or libraries to the more widely used software packages.

PHASE I: Identify the most promising biological neural networks for general engineering applications in signal processing, pattern recognition and/or control. Develop a system design for a software package or extension to a standard package for identified biological neural networks and learning rules. Develop an efficient implementation of at least one of these biological networks, with user-friendly interface.

PHASE II: Develop a complete software package, or set of extensions for a commercially significant software tookit, incorporating a number of the biological neural networks and learning rules. The system should have flexibility and ease of use, and take advantage of high performance microprocessors, or accelerator cards for high throughput and shortened training times. Demonstrate the performance of this package on a difficult pattern recognition or control problem.

PHASE III: Prepare the software package for commercial and DoD use, including debugging and documentation.

COMMERCIAL POTENTIAL: Artificial neural network software is now widely used in many industries and services, and is estimated to be a $1 billion industry. Networks with demonstrated training and performance advantages will be made available for wide spread use

REFERENCES: Zornetzer, S.F. et al.(Eds.), An Introduction to Neural and Electronic Networks, 2nd Edition, Academic Press, San Diego, CA, 1995.

N96-169 TITLE: Smart Analog Vision Chip with Spatio-temporal Filtering

OBJECTIVE: Computational sensors -- that is, smart vision chips; also known as on-focal plane array processors -- which will detect significant temporal changes in pixel intensity and report these locations so as to direct the attention of image coding algorithms to these regions for intensive analysis.

DESCRIPTION: Spatio-temporal changes (e.g., motion) in visual scenes provide a powerful cue to human viewers, drawing attention and an intensive analysis of active sub-regions. However, current methods in computer vision for coding images focus on quasi-static images, neglecting the all-important temporal domain. One approach for overcoming this limitation is to compute the optical flow field, mark the region with the most significant motion field, and use this information to perform localized image coding. Digital techniques that implement optical flow and other algorithms are computationally very intensive. A cheap, small, low-power and real-time alternative might consist of analog image processing circuits that continually analyze the incoming image. When significant changes are detected, presence and location of these events are reported to subsequent systems for in-depth analysis. The processor must be operational in both an infrared and visible band focal plane array.

PHASE I: Comparison and selection of algorithms, and development and simulation of chip architecture.

PHASE II: Vision chip design and fabrication via commercial CMOS foundry. Interface to PC to demonstrate functionality.

PHASE III: Development of integrated system, including optics, programmable microprocessor and interface, to be used in stand-alone application.

COMMERCIAL POTENTIAL: Smart vision chips are expected to be of use in many military, commercial and home applications, ranging from smart target detection and homing devices to chips for autonomous vehicle navigation for automobiles to video conferencing and clinical applications. Major advantages of this technology are affordability, speed and compactness.

REFERENCES: Koch, C. and Li, H. (1994) Vision chips: implementing vision algorithms with analog VLSI circuits. IEEE Computer Science Press.

N96-170 TITLE: Novelty Detection for Condition-based Maintenance of Mechanical Systems Using Neural Networks

OBJECTIVE: Develop neural network architectures and/or algorithms for the detection of novel (presumably faulty) status data from continuously operating mechanical systems for use in condition-based maintenance of these systems. Novelty detection is defined as the recognition of faulty system states when prior training has been limited to "no fault" data only.

DESCRIPTION: The Navy is interested in applying biologically-realistic neural networks to the recognition of faulty states of mechanical systems. These devices must be robust in recognizing faulty states even when trained on "no fault" data only. The neural network architectures must be novel and based on biologically-realistic neuronal systems found in animal and/or human nervous systems. The mechanical devices may be pumps, gears, or other devices or they may be large-scale structures in motion (e.g., aircraft) and under stress. The status data are vibration data from collection points on the mechanical system (e.g., accelerometers).

PHASE I: Develop neural network architecture, apply to sample data sets to show feasibility of system for the detection of faulty mechanical devices, and compare with current methods of fault detection.

PHASE II: Develop, test and operationally demonstrate a complete fault diagnostic system under realistic field conditions for one or more mechanical devices, conduct field tests and evaluate this system for at least six months of normal operation, and compare to alternative methods for fault detection.

PHASE III: Produce a complete product which implements the architecture developed and refined in Phase II.

COMMERCIAL POTENTIAL: There is a clear widespread potential for industrial machinery involving rotational machinery (e.g., pumps) as well as civilian aircraft and other large systems under routine stress. Likely commercial clients include manufacturers of such systems, current owners of such systems, and insurance companies which insure against damage and loss due to failure of such systems.

REFERENCES: Petsche, T., Gluck, M., Hanson, S. (1994) Workshop on Novelty Detection and Adaptive System Monitoring. Neural Information Processing Systems, 7.

N96-171 TITLE: Operation Evaluation of Advanced Integrated Air Vehicle Suites

OBJECTIVE: To develop methodology/tools in predicting and qualifying/quantifying the operational benefits of 'smart' air vehicle components/systems integration efforts.

DESCRIPTION: Aircraft subsystems have traditionally been developed as stand alone systems and only integrated at the subsystem or vendor level and not at the vehicle level. This has created a myriad of control approaches that were not tightly coupled limiting future integration efforts. Recognizing this, the Navy is (in the exploratory development phase of) developing a Vehicle Management Avionics System (VMAS) to continually monitor and control the health and performance of the aircraft. However, it is very difficult to quantify the benefits of an integrated aircraft system approach in terms of operational measure of effective (MOE) and measure of performance (MOP). To complicate matters, future air vehicle system will exhibit 'smart' components (i.e., smart structures) that contain a high degree of intelligence offering reconfigurable vehicle systems. Coupled that with development in data fusion and cognitive decision aiding knowledge base systems will enable additional operational capabilities. These integrated and intelligent systems will provide the pilot coordinated control of the available air vehicle systems in response to degraded and emergency situations, making the aircraft more battle damage tolerant, less vulnerable and more survivable. No clear methodology exists to evaluate these smart system capabilities and obtain a first order benefits analysis of these technologies in terms of MOEs and MOPs either at the mission level, or campaign level. Existing MOP and MOE simulation techniques do not have the flexibility to account for these type of vehicle enhancements. This analysis is needed to show the impact on aircraft availability and life cycle cost (LCC).

PHASE I: Feasibility study to define and identify promising approaches which can be used to quantify the MOE/MOP of aircraft equipped with smart air vehicle components and systems. Identify simulation tools to support the selected methodology.

PHASE II: Optimize the simulation/evaluation tool(s) and provide a prototype demonstration of the concepts defined in Phase I.

PHASE III: Transition the technology into F/A-18 E/F and/or JAST or an advanced technology demomstration (ATD).

COMMERCIAL POTENTIAL: The products developed under this effort will include avionics design methodologies, design software and computer simulation tools. Application areas include, but are not limited to commercial avionics and automotive electronics development.

N96-172 TITLE: Incorporation of Gap Effects in the Design of High Performance Missile Control Fins

OBJECTIVE: Develop and implement new technology for the design and analysis of high-performance missile control fins including gap effects.

DESCRIPTION: The design of high performance missile control fins is aimed at maximizing lift and minimizing actuator torque requirements. Although efforts have been undertaken in the areas of fin platform optimization and chord-wise flexibility to satisfy aerodynamic objectives subject to geometric and other constraints, the effects of gaps have not yet been considered in the optimization process. Gaps appear at the root chord of control surfaces where the span-wise loading is likely to be a maximum, and where changes in the lift distribution can have large effects on hinge moment. Thus advanced control design methods must include these effects based on knowledge gained from a combined theoretical/experimental approach to analyze the flow details in the gaps. The ultimate objective is a comprehensive tool capable of handling gap effects in the design of missile control fins optimized to satisfy user-specified aerodynamic objectives subject to constraints.

PHASE I: Develop techniques for designing effective controls including gap effects. Include methods for accurately analyzing the performance of selected controls including suitable CFD gridding techniques, such as those indicated in Ref. 1, applicable to analyzing the flow in fin gaps. In this phase, demonstrate feasibility by generating flow solutions and comparing results with available data such as that provided in Ref. 2. Provide a plan for the experimental program to be performed as part of Phase II.

PHASE II: Generate flow solutions with the basic grid strategies developed in Phase I, examine among other things the effects of shock/boundary layer interaction in the gap and effects on fin aerodynamic loads. Extend the gap calculations to non-stream-wise gaps and non-circular body cross sections. Compare results with available data. Incorporate the theoretical/experimental findings in a missile control fin design method. Design promising low hinge moment fin configurations including fin gap root chord/body contours optimized for fin lift, minimum actuator torque, and controlled vortex (fin wake) formation. Conduct an experimental program to validate the designs. Develop a commercially marketable code.

PHASE III: Make available techniques for designing and for accurately calculating the aerodynamic characteristics

of missile controls including gap effects. Apply the techniques to improve the performance of future missiles. Address dynamic effects, such as post-stall performance, and indicate how they might influence control fin design.

COMMERCIAL POTENTIAL: A comprehensive design code for lifting surfaces which includes effects of gap between the surface and another component such as the body or another portion of the lifting surface will be of great utility to the aerospace industry for applications to high performance missile control fin and aircraft aileron, flap, and other control surface designs. In addition, the design code will be useful to designers of submarine control surfaces, gas turbine blades, and windmill blades with movable portions for controlling speed.

REFERENCES:

1. Van Dyken, R., "Computational Analysis of a missile at high angle of attack", *Naval Research Reviews,* Vol. XLVII, Two/1995.
2. Schindel, L., and Lam, L. "Payoffs of Improved Control Effectiveness", AIAA paper 95-1898, June 1995.

N96-173 TITLE: Superconductor Applications to Aircraft Electric Systems

OBJECTIVE: To investigate various superconducting materials to determine if they are currently within five years of being applied to aircraft electric power generation and distribution components. To design and fabricate a prototype superconducting electrical system component.

DESCRIPTION: Current electric systems provide, at best, system efficiencies of 70-85%. These efficiencies are low because of the inherent losses within the generator and distribution system wiring. The impact of these losses in an aircraft electric system translate into high specific fuel consumption (SFC), reduced time on station, reduced payload capability, and high electric system weight.

Superconducting materials will have a large impact on electric system weight, efficiency, reliability, and survivability. Using superconductive materials to replace conventional copper conductors in generator/motor winding or as core material would provide lighter weight devices. Superconductors are also candidates for the electric system distribution cables. Electric system efficiency would increase from present efficiencies to 98%. This is due to the zero resistance characteristic of superconductors.

Recent advances in producing high temperature superconducting materials make them more realistic for application to aircraft power systems since cryogenic systems required for cooling are much simpler and smaller than those cryogenic systems of the lower temperature superconductors.

PHASE I: Phase I should consist of the study that will identify the aircraft electric components in which superconductor materials will have the largest impacts. Weight, reliability, survivability, and efficiency must be considered during the study. This study should result in the selection of an electric system component most near term for development and a preliminary design of this component.

PHASE II: Phase II should result in a final design and the fabrication of the superconductor component identified in Phase I. Initial functional testing shall be performed by the contractor prior to delivery to the government.

PHASE III: Phase III will result in testing and evaluation of the component fabricated in Phase II. Further development efforts may be conducted depending on the results of Phase I and Phase II.

COMMERCIAL POTENTIAL: Superconducting components have applicability across most electrical systems, including civilian aircraft systems.

N96-174 TITLE: Model Development for Shock-Induced Reactions in Non-Explosive Materials

OBJECTIVE: Develop constitutive models for the mechanical shock compression and release behavior of selected non-explosive materials, with emphasis on shock-induced chemical reactions for rapid production of heat and gases.

DESCRIPTION: The Navy is evaluating the rapid production of gases from non-explosive sources. The shock compression and release processes in selected porous materials (powders and/or foams) has the potential for replacing common explosive and propellant formulations as generators of heat and gases for actuators, ejection systems, and various ordnance-related items, to achieve improved safety for manufacturing, storage, and operational use.

PHASE I: Develop basic analytical mathematical models applicable to several porous material systems to be specified by the Navy. These models will include effects of initial density, particle and/or foam morphology, shock stress amplitude,

risetime, and duration for initiating reactions that produce heat and gases, and the relative time-dependent yields of the produced compounds in terms of the threshold stress conditions and the amount by which the threshold conditions are exceeded. The material specimen geometry for initial consideration would be a disk of material, with a transient mechanical shock stress applied uniformly over one of the flat surfaces, and would include the effects of shock compression and release waves in the specimen.

PHASE II: Extend models developed in Phase I to address more complex materials systems to be specified by the Navy. Integrate models into an established dynamics simulation code (e.g., CTH, EPIC, or DYNA3D) to address complex boundary geometries and the mechanical interaction of produced gases with boundary materials. Use the resulting computational simulation capability to predict the dynamics of selected Navy-supplied problems.

PHASE III: Enhanced Warhead Advanced Technology Demonstration scheduled to begin in FY 1998.

COMMERCIAL POTENTIAL: The models and simulation capability would find application in the design of vehicle air bags, shock mitigation systems, and other safety-related items for civilian use.

N96-175 TITLE: Microscopic Investigation of Rocket Propellant Processing Parameters on Cure Shrinking

OBJECTIVE: Control cure shrinkage in rocket motor propellant through the use of grain design, temperature and pressure through a thorough understanding of propellant ingredient and cure phenomena.

DESCRIPTION: Many of the rocket motors manufactured for the Navy have used a cure to height grain former to save machining costs. This technique exacerbates the effects of cure shrinkage of the propellant creating visible voids, unbonds and dendrite cracks in propellant. These defects can result in motor failures. Cure shrinkage is a phenomena of the reaction of the binder with the curative and always occurs in propellants. Although the physical sign of cure shrinkage are well known in the propellant industry, the extent of the non-visual damage to the microscopic structure of the polymer network is unknown. Sidewinder, HARM, and AMRAAM are examples of motors being produced with cure shrinkage. With current production of these motors coming to an end and new propellant formulations forthcoming, it is imperative that the Navy understands the phenomena of cure shrinkage and its effects on motor shelf life.

PHASE I: Provide a study of the cure shrinkage phenomena of the hydroxyl terminated polybutadiene (HTPB) binder with various curatives (IPDI,DDI) and plasticizers (DOA,IDP) currently used in the propellant industry. Use a baseline propellant formulation similar to HARM and Sidewinder propellants at various solid loading conditions. Study ammonium perchlorate/aluminum (AP/Al) loaded propellants and the effects of cure shrinkage. Study and develop means of controlling the cure shrinkage that will lead to better processing and understanding of propellant physical properties. Develop high level models, incorporating key parameters based on the findings.

PHASE II: Design and develop a test motor that will induce cure shrinkage effects into the propellant grain. Measure the physical values of the propellant throughout the motor and around the induced voids and cracks. Look at the microscopic structure of the propellant binder network. Investigate accelerated aging effects. Develop methods to control and eliminate the detrimental effects of cure shrinkage. Modify the high level mathematical models based on the data collection/extension of other models.

PHASE III: Demonstrate the understanding of the cure shrinkage phenomena by producing full scale motors with long length to diameter ratios (greater than 10 to 1). Induce cure shrinkage into half of the motors and provide half of the motors with damage free propellant by implementing cure shrinkage fixes. Cold X-ray all motors. Temperature shock cycle a statistical quantity of each motor type to failure. Accelerate age motors for one year and then temperature shock cycle motors to failure. Modify the high level models based on the scaled up data.

COMMERCIAL POTENTIAL: Understanding this phenomena of propellant cure will allow the NASA/private sector to obtain better rocket motors with longer shelf lives by including proper requirements in production contracts. A better understanding of service life of motors will also be obtained. This technology can be applied to polymer resins and adhesives in the manufacture of plastic and composite parts in multiple industries.

N96-176 TITLE: Rapid Positioners for Precision Manufacturing

OBJECTIVE: Design, develop and demonstrate a positioning system which enables significantly higher production rates in precision manufacturing.

DESCRIPTION: One of the factors which limits throughput in precision manufacturing is the rate at which tools can be

repositioned so as to minimize errors from processing operations. A typical positioning system consists of a piezoelectric actuator, a position/velocity sensor, and a feedback control loop. The speed of such a system is often dictated by how fast the control loop can respond. This effort would advance control loop performance through innovative approaches such as active damping and sensorless feedback. Speed improvements by a factor of 10 or more are expected.

PHASE I: Design, fabricate and test a generic positioning system which incorporates the proposed control loop innovations. Demonstrate that this system has a significantly enhanced response speed as compared to a well engineered conventional positioning system. A limited range of motion of about 10 micrometers in 3 dimensions is acceptable.

PHASE II: Develop and demonstrate a prototype positioning system with the full range of expected motion for a specific manufacturing operation, such as diamond turning,

PHASE III: Develop a well engineered positioning system for precision manufacturing suitable as a commercial product..

COMMERCIAL POTENTIAL: Rapid positioning systems based on these advanced concepts would have a major payoff wherever dynamic response is an important factor. Potential commercial applications include auto-focusing lenses, bubble jet printers, anti-lock brakes, and audio speakers.

REFERENCES:

1. D. G. Luenberger, "An Introduction to Observers," IEEE Transactions on Automatic Control 16, 596 (1971).
2. R. D. Lorenz and K. Van Patten, "High-Resolution Velocity Estimation," IEEE Transactions on Industrial Applications 27, 701 (1991).

MARINE CORP SYSTEMS COMMAND

N96-177 TITLE: Composite Mine Vehicle Survivability Kit

OBJECTIVE: To develop a low cost, efficient lightweight composite material that will provide vehicle crew protection during mine encounters.

DESCRIPTION: The USMC has been developing crew/vehicle protection kits to provide increased crew survivability for tactical wheeled vehicles. Commonly encountered threats include on-route large blast mines with an additional threat of off-route fragmentation mines. While the USMC is achieving success against the threat levels of mines/fragmentation with conventional steel/aluminum protection kit fabrication, there are payload and mobility penalties associated with these protection kits. This research area is targeted at reducing these penalties while still providing the same level of crew/vehicle protection or improving the energy absorption performance of deflectors.

The protection kit will protect the crew from blast, fragments, and injurious acceleration effects of blast mines up to the equivalent of 16 pounds of Composition B. The composite material should mitigate more than 50% of mine energy, through absorption (material deformation) and blast deflection. Vehicle vertical and lateral acceleration should be minimized. The following are typical loading curves from a mine blast under a steel/aluminum protection kit:

Max Pressure Over Time	Max Stress Over Time
3000 ATM @ .74 millisec	67K PSI @ 5 millisec
1400 ATM @ .23 millisec	71K PSI @ 15 millisec
150 ATM @ .58 millisec	72K PSI @ 25 millisec
	60K PSI @ 30 millisec

PHASE I: Addresses the full matrix of tradeoffs for materials, performance, performance penalty, and manufacturability. Included in the matrix should be maintenance, quality control and cost variables. Phase I efforts which propose to accomplish this study and proceed to actual materials work will be weighted. The proposal must address, in detail, techniques for composite technology assessment of design without relying on costly repetitive testing and demonstration. It is not critical that the proposer address hardware configuration for the protective kit. But contractor must demonstrate they are using a process which can produce the items in general lengths/widths/thickness and surface relief. Military corporate knowledge can assist in this phase of development. Phase I proposal must contain at least an outline of the Phase II plan.

PHASE II: Composite construction and evaluation will be conducted. Of primary importance is the blast/acceleration energy absorption protection offered by the composite material as compared with vehicle weight penalty. Phase II will also address additional materials parameters of induced vehicle vibrations, climatic response conditions, manpower, etc. The proposed process must be low cost and easily adapted to new component designs/configurations.

PHASE III: The commercial composite material process development and validation should be completed. Kits should

be ready for fabrication and operational testing by military installations for selected vehicle frames. The commercial marketing plan submitted with Phase II should clearly specify additional uses for the composite material. These efforts should be pursued independently by the contractor to ensure a viable source for material production.

COMMERCIAL POTENTIAL: Lightweight composites are finding many applications in the recreation industry. Security issues are increasing in the commercial sector which would provide ample opportunity for a lightweight ballistic material application. The aerospace industry is growing, with a high need for lightweight extremely resilient materials for satellite/space flight payloads.

REFERENCES:
1. Army Military Command (AMC) Polymer Matrix Composites Assessment, August 1991;
2. 1993/94 Annual Report, University of Delaware Center for Composite Materials; "Blast and Structure Simulation/Analysis for Development of a Centerline Blast Deflector for the Cab of an M723A2, 5 Ton Cargo Truck", SAIC, 2 May 1994;
3. "Blast Simulation and Analysis", SAIC, Science Applications Int. Corp., 30 May 94; "Development of Mine-Resistant Vehicles", SAIC, 2 July 1993;
4. "Lightweight Hull floor Program", LH-92-80711-001, General Dynamics Land Sys Div, Jan 1993

N96-178 TITLE: Anti-Personnel Obstacle (APOBS) Breaching System Manufacturing Technology

OBJECTIVE: The Anti-Personnel Obstacle Breaching System (APOBS) is a line charge system that consists of 108 grenades fastened to ropes that are propelled by a small rocket. It is intended to clear wire obstacles and anti-personnel mines. The grenade rope fabrication process is presently accomplished using a banding machine that clamps metal bands over the grenade and ropes. There is a critical need to identify alternative manufacturing sciences that will increase production reliability and reduce manufacturing costs.

DESCRIPTION: The manufacturing technique will focus on the assembly process connecting the nylon ropes to the oval grenade. The fastening process must: (1) Be capable of withstanding the dynamic loads seen by the current banding system during APOBS employment;(2) Be of a design and material that does not exceed the weight of the current grenade clamping system-with a goal of further reducing weight;(3) Be of a design and material that is compatible with the manufacturing and/or fabricating processes of Class V explosives used in the APOBS;(4) Meet or exceed the test requirements used to test the current banding system which is required to withstand 250 LBS. of pull before the clamps slip off the rope;(5) Be of a material and design that will not appreciably change properties when exposed to storage and operational extremes of heat, cold, and humidity. This ranges from -60 to 160 degrees Fahrenheit and 0 to 100% humidity;(6) Be composed of environmentally safe materials;(7) Be of a material design that will not degrade or appreciably change properties during a storage life of 15 years;(8) Be of a design that continues to allow the string of grenades to be coiled and fit into the current container used for storage, transportation, and employment;(9) The proposed new procedures for fastening the grenades to the nylon ropes must demonstrate low cost, simplicity, and repeatability in a manufacturing or fabrication environment.

PHASE I: Design a fastening, bonding, clamping or any other mechanism to securely fasten the ropes to the grenades. Evaluate all the concept, identify costs and availability, and provide a report on this feasibility. Proposers reaching the hardware stage within Phase I will be given weighted consideration. The Phase I proposal must contain the Phase II effort in at least outline form.

PHASE II: Demonstrate a proof of concept prototype for the two most promising manufacturing/fastening technique's concurred with by the Project Program Manager. Test and demonstrate the two prototypes. Provide a Phase II report that includes the Phase III. plan.

PHASE III: The contractor must mature the fabrication procedure to the point that it merits commercial production consideration. This includes total costs associated with the procedure.

COMMERCIAL POTENTIAL: This would have wide spread commercial and military applications that require irregular surface bonding technology. The Safety Industry could greatly benefit by having an inexpensive means to attach safety equipment to ropes. Recreation applications may also be possible especially in Sailing where knots could be reduced. Additionally, the technology would have application in foreign countries that are striving to improve their economies but are limited due to the mining of the terrain.

N96-179 TITLE: Battlefield Information Warfare

OBJECTIVE: The objective of this topic is to determine the application of Information Warfare (IW) techniques on the battlefield to attack tactical adversary Command Control and Computer (C2) systems.

DESCRIPTION: IW Attack on the battlefield: Battlefield techniques effecting adversary Information, Information Based Processes, and Information Systems outside of traditional Electronic Attack (EA) applications of C2W. Potential targets could include, but are not limited to, computers, fiber optics, modems, and computer based sensors.

PHASE I: Design information warfare tactics, strategies, and matching technologies applicable to electronic attack of information systems targets as described above. The design should include details of hardware and software required. The application of these solutions will be on a conventional battlefield and for military operations other than war (MOOTW). The emphasis will be on tactical systems as opposed to strategic or national information infrastructure. In addition to designing technology and techniques, a system concept and requirements analysis should be delivered with proof of concept performed via modeling and simulation if possible. The focus of this topic is Information Attack, however, friendly systems vulnerabilities must be considered as well. Conduct an analysis to identify those strategies that will be most effective in the conduct of battlefield IW. Report in detail this feasibility effort.

PHASE II: Demonstrate the ability of the selected system(s) designed in Phase I, to disrupt C4I networks and equipment. Provide prototype of equipment and software developed during Phase II based on proof of concept developed in Phase I. From the lessons learned, transfer vulnerability information to Command, Control, Communications, Computers, and Intelligence (C4I) Information Security programs.

PHASE III: With supporting doctrine, build, test, and procure hardware and software solutions, sufficient IW attack systems for integration into the MEWSS system to meet projected Marine Corps requirements as determined by the appropriate requirements validation authority.

COMMERCIAL POTENTIAL: While the application of this research to commercial products would be limited due to security considerations in the law enforcement community. Also, application exists in developing, form the lessons learned in attacking information systems, appropriate information protect procedures for commercial networks particularly those involved in cyber-commerce.

REFERENCES: Joint Chiefs of Staff, Memorandum of Policy 30, 8 March 1993; Information Warfare Technologies: Survey of Selected Civil Sector Activities, Draft November 1995, Institute for Defense Analysis, D-1792

N96-180 TITLE: Deployable Power Distribution System

OBJECTIVE: To develop an innovative single lightweight power distribution system with companion wiring harness connectivity, providing autonomous intelligent distribution configuration for multiple generator inputs and multiple equipment outputs.

DESCRIPTION: The USMC relies on families of generators for deployable power, ranging nominally from 3KW to 100KW. Distribution of this power is presently provided by a parallel family of distribution systems, consisting of a cabinet, breakers, and input/output receptacles. Each distribution system is designed for different power grids, providing multiple 120/208 volt, 1-phase loads. The 15KW distribution panel weighs approximately 56 lbs per panel, consists of 10 total panels, and requires a stowage of 50.6 ft cubed. The 30KW distribution panel weights approximately 161 pounds per panel and requires a stowage of 132 ft cubed. The 100KW distribution panel weighs 345 lbs per panel and requires 388 ft cubed of stowage. The USMC would like to reduce the weight/cube of its present inventory by combining these separate units into a single comprehensive distribution unit. State of the art technology will allow this single lightweight panel to facilitate power distribution from various KW-rated generators at the same time. The proposed unit weight/cube must be commensurate with present minimum weight/cube limits. Also considered in this development is lifecycle maintenance as well as receptacle versatility. Power panel output receptacles presently focus on direct hard wiring of equipment. Inventory wiring harness kits are available to provide distribution of electrical power to the field tents and shelters. However, there is need for an innovative solution for rapid connection of the wiring harness/equipment cables to the distribution panels. The solution should address time/manpower/safety for rapid connect/disconnect while leaving the electrical harnesses completely reusable.

PHASE I: Phase I should identify the technology used in designing a single unit power distribution panel which can facilitate the full 3-100KW range of power generators. The unit proposal must address weight/cube. Technical details of system capacity, proposed input/output connection schemes, and protective circuitry must be detailed. Modularity should be considered.

Proposals with proof-of-concept hardware in Phase I will be weighted.

PHASE II: The Phase II demonstration will entail developing several field-testable prototypes. Development will also include manufacturing practices, packaging, display optimization, innovative materials investigation for connect/disconnect, etc. Possible integration of self-diagnostics, percent loading display, etc. will be addressed.

PHASE III: This product, based on Phase II progress, will be identified for inventory inclusion in the USMC family of Power Equipment Assorted.

COMMERCIAL POTENTIAL: The power industry as well as field testing facilities in a variety of disciplines would benefit from this development. Applications exist in the construction, mining, camping industries, and disaster relief.

REFERENCES: TM11275-15/3C, pg 2-58 through 2-61; NSN 6110-01-272-6952/6953; NSN 6110-01-273-2387; NSN 6150-01-254-1666 (wiring harness); Navy MIL-STD MIL-P-29183/2/6 panel boards, power distribution, portable; Navy MIL-STD MIL-C-29184/1 cables and connectors

N96-181 TITLE: Multipurpose Lifting/Excavating Arm

OBJECTIVE: Develop a lifting/excavating arm that can readily attached and detached to vehicles, specifically the M-9 Armored Combat Earthmover.

DESCRIPTION: There is a requirement for a multipurpose arm that can be attached to the M-9 ACE using its existing hydraulic system. The arm must be capable of: 1.) lifting a minimum of 4,000 pounds with a desire of 10,000 pounds and placing it in the bowl of the vehicle. 2.) requires an attachment that can be used for excavating. 3.) requires an attachment that can be used for auguring a minimum of 12 inches with a desire of 24 inches in diameter and 4 feet in depth.

PHASE I: Investigate feasibility and methods of attaching an arm to the M-9 ACE as well as develop functional specification. Develop system configuration, evaluate concepts and report on the results. Proposers reaching the hardware stage within phase I will be given weighted consideration. The Phase I proposal must contain the Phase II effort in at least outline form.

PHASE II: Develop a proof of concept prototype, test and demonstrate the prototype, plan Phase III, and report.

PHASE III: Phase III will require military program sponsorship. For successful advance to this phase, a successful proof-of-concept must have been demonstrated, and the USMC sponsor for this SBIR effort will have coordinated transition to demonstration/validation. The contractor must support a successful Phase III transfer by maturing the product to a point for commercial consideration, including manufacturability and cost.

COMMERCIAL POTENTIAL: This arm would have wide spread commercial and military applications. The arm would have the ability to attach to existing platforms that have hydraulic systems. For example construction firms could buy this arm attachment mount it to an existing vehicle instead of purchasing an additional vehicles that would perform the same task. Other military applications would apply as well. For example units could have this arm attached to a non-engineer vehicles therefor, freeing the limited number of engineer assets to perform more critical missions.

N96-182 TITLE: TRSS Air Delivered Target Acquisition Sensors

OBJECTIVE: The objective of this topic is to validate the application of target acquisition sensors which can be delivered from Marine Corps/Navy high performance tactical aircraft in support of amphibious operations and expeditionary operations ashore. Such Sensors would become an integral part of the USMC Tactical Remote Sensor System (TRSS).

DESCRIPTION: TRSS is an existing suite of systems which, in combination provide Marine commanders the capability to remotely monitor areas of interest with minimal manpower resources. The proposed sensor would overcome a current inability to emplace and monitor activity in areas beyond the safe operational range of rotary-winged platforms and ground reconnaissance forces. Additionally, this sensor needs to be able to discriminate between various vehicle types sufficiently to improve targeting by Marine Air Ground Task Force (MAGTF) weapons systems.

PHASE I: Explore the application of technologies required to passively classify tactical targets to the degree necessary to identify specific types of combat vehicles employed by possible opposing forces. This phase should also address the packaging of such technologies into stores which can be easily integrated into existing aircraft stores delivery systems. Specifically, Phase I should address sensor performance goals and provide evidence that the goals are technically feasible as well as identify all

necessary efforts required in Phase II.

PHASE II: This phase entails the demonstration of the proposed sensor to include: detection, self location, target classification, target location, direction of motion, delivery from a Marine Corps high performance tactical aircraft, and integration into the existing USMC TRSS. Target classification refers to the ability to distinguish between vehicles types, e.g. T-72 Tank, M1A1 Tank, Bradley IFV, etc.

PHASE III: Produce the hardware developed in Phase II of this effort.

COMMERCIAL POTENTIAL: Application of this research will benefit numerous security system manufacturing companies seeking to target specific activity in highly active distant locations. additionally, such technology has a wide range of applications in law enforcement and the defense industry. There also be a requirement for acoustic recognition in the maintenance diagnostics fields for machinery, automobile engines, or medicine.

N96-183 TITLE: Knowledge-based System

OBJECTIVE: Using Intelligent Agent technology, automate the reasoning process used by commanders in making decisions to execute command and control.

DESCRIPTION: The proposed Knowledge-based system will solve the problem of how to symbolically represent information about complex real-world entities and processes, and how to reason with this information in time for the results to be useful. The system should address knowledge representation, automated reasoning, and automatic planning.

With the use of techniques from Artificial Intelligence called "autonomous agents", implement a style of user interaction in which human and computer agents both initiate communication, monitor events, and perform tasks.

PHASE I: Investigate available Intelligent Agent architectures, agent languages, and agent technology applications. Based on available agent technology, identify an architecture suitable for command and control and appropriate applications. Prepare a report with the results and recommendations for the Phase II effort.

PHASE II: Develop a prototype system based on the recommended agent architecture. Implement software agents which interoperate as applications in this environment to demonstrate proof of concept.

PHASE III: Implement and integrate more complex software agents that provide automated decisions in which the user has confidence, in addition to a social interface where the user has the feeling of being in control.

COMMERCIAL POTENTIAL: Today the dominant form of human interaction with computers is via commands and/or direct manipulation initiated by the user. This mode of operation will have to change as more untrained users are introduced to the world of computers and networks of tomorrow. The use of Intelligent Agents can assist users in several ways: they hide the complexity of difficult tasks, they perform tasks on the user's behalf, they can train or teach the user, they help different users collaborate, and they monitor events and procedures.

REFERENCES: Communications of the ACM, July 1994 - Volume 37, Number 7

N96-184 TITLE: Ultra-WideBand Antenna

OBJECTIVE: Develop/identify High Power Microwave-Ultra-WideBand (HPM-UWB) antennae, suitable for employment in the various tactical environments that Marine Corps use requires.

DESCRIPTION: Physical antenna parametrics are typically tailored to provide the desired directivity and gain for a relatively narrow bandwidth (as a percentage of center frequency). Ultra-wideband signals and high power microwave, create a family of problems for antenna optimization and will require the development of new techniques or modification of existing techniques to provide for efficient coupling of electromagnetic energy to the atmosphere. Desirable attributes are beamwidths tunable from hemispherical to quadrant or better, with an appropriate positive Db gain. These antennae will be principally used for transmission but may have applications for detection as well.

PHASE I: Explore the potential solutions to the problem of efficient coupling of high powered microwave and ultra-wideband electromagnetic energy to the environment. Phase I should focus on the efficient coupling of HPM-UWB energy as well as addressing the appropriate techniques to address directivity.

PHASE II: Using the concepts developed in Phase I, demonstrate the ability of the selected antenna application and techniques to efficiently couple the RF energy with the environment.

PHASE III: With supporting doctrine and force structure, build test and procure sufficient UWB antenna systems to meet projected Marine Corps deployment of HPM-UWB generators as determined by the appropriate requirements determination authority.

COMMERCIAL POTENTIAL: With the growing family of communications and entertainment systems, antenna technology has come to the forefront in an effort to maximize performance while minimizing cost and providing a non-obtrusive profile. The developer of the this antenna could potentially market this item or products derived from lessons learned, into one of the burgeoning markets for antennae.

N96-185 TITLE: Detection of Unexploded Ordnance (UXO)

OBJECTIVE: The objective of this topic is to develop a man portable system, based on Nuclear Magnetic Resonance technology to enhance and improve the detection of all types of UXO regardless of case composition. This would be accomplished by detecting the primary explosive instead of the UXO case material.

DESCRIPTION: While in the past, the majority of all UXOs have been magnetic and/or metallic, in the future they are expected to have a higher and higher concentration of composite material casing. Most operational locators are severely handicapped in the detection of plastic or composite type materials and a need exists for a technology that is capable of detecting the basic element of the UXO i.e. the explosive. Past efforts involving several different technologies indicate that Nuclear Magnetic Resonance techniques offer significant promise in the detection of various explosives regardless of the type of exterior case. While other technologies may be able to detect explosives they have exhibited serious limitations both with the environment and with UXO case composition. In addition, some that would be otherwise suitable, are not considered for man portable operation because of safety issues.

PHASE I: Demonstrate the feasibility of detection either with rigorous mathematical analysis or through laboratory demonstration.

PHASE II: Develop a fieldable prototype capable of man portable performance.

PHASE III: Implementation into one or more of the ongoing UXO clearance programs.

COMMERCIAL POTENTIAL: While the detection of solid explosives has very limited application with police and anti-terrorist organizations, the technology might also be expanded to detect other potentially toxic or explosive chemicals that may be present in the ground or behind sealed walls.

N96-186 TITLE: State of Charge Monitoring for Hybrid Electric Vehicles

OBJECTIVE: The objective is to improve vehicle fuel efficiency and operating range of future hybrid electric vehicles.

DESCRIPTION: Hybrid electric vehicles are being developed for both commercial and military applications. In all instances, batteries on-board the vehicle are used for energy storage and buffering of power between the engine/generator and the drive motor(s). An accurate state of charge indication of the battery pack is critical for proper operation of the engine/generator and for maximum fuel efficiency. The state-of-charge will determine the on-off operation and the duty cycle of the engine which ultimately affects fuel usage and fuel efficiency.

PHASE I: Explore software and hardware based solutions to accurately and in real-time provide indication of the state of charge of battery packs that utilize both lead acid and nickel-cadmium technology. The battery pack shall operate in the 300-400 Volt range with through put power capability of 75 to 100 kilowatts and energy storage ranges of 5 to 20 kilowatt-hours. Electrical schematics, hardware concept drawings, and software and logic flowcharts shall be delivered at completion of Phase I.

PHASE II: Using the chosen design for a single battery technology, a brassboard system shall be developed and delivered, with interface information, for on-vehicle test purposes.

PHASE III: Ruggardize, miniaturize, implement and test in hybrid-electric vehicles.

COMMERCIAL POTENTIAL: The Clean-Air and Zero Emission vehicle mandates that take effect in 1998 are requiring electric and hybrid-electric vehicles in increasing numbers. Maximum efficiency from the on-board stored energy (battery) and user confidence that the battery will propel the driver/passenger to the destination is required for electric vehicles to have commercial acceptance. Current technology can not provide this capability. With greater use of hybrid-electric vehicles in the future, accurate

knowledge of state-of-charge is critical for reliable and clean operation of the automobile.

NAVAL AIR SYSTEMS TEAM

N96-187 TITLE: Fretting and Wear Resistant Blade/Vane Coatings

OBJECTIVE: Develop fretting and wear resistance for Gas Turbine Engine Blades and Vanes in attachment areas using surface modification techniques other than traditional plasma sprayed (Cu-Ni-In, Ni-Graphite, etc.) coatings.

DESCRIPTION: Navy gas turbine engine blades and vanes typically have plasma sprayed anti-fretting and wear resisting coatings on their mating surfaces. Difficulty is often encountered in producing dense, tightly adhering, uniform coatings using this coating method even though the method has been used for many years. The coatings often have different properties, part to part, due to slightly different application parameters. This leads to uneven wear rates and possible catastrophic early failures.

New coating technologies may provide fretting and wear resistance comparable or better than the traditional coatings. As with any new technology, undesirable characteristics might also be present, therefore, properties such as fatigue, etc. must be quantified and related to overall coating performance. This effort will identify, qualify and develop new coating technologies for anti-fret and anti-wear conditions.

PHASE I: Provide a feasibility study to identify components eligible for this program, identify new coating technologies (PVD, ion implantation, CVD, etc.) and coating materials (DLC, PVD/MoS2, TiN, etc.) with suitable properties to be considered, and propose methods for evaluation, testing, qualification, and implementation of the new coatings into Navy gas turbine engines.

PHASE II: After verification/validation of the candidates with appropriate Navy personnel, the candidate coatings will be laboratory tested to provide fretting, wear, fatigue, and other appropriate test data to determine suitability for continued consideration. Actual engine components will be coated to prove applicability and will then be tested either in engines or in engine running conditions. This test data will be used to obtain approval from the controlling Navy office.

PHASE III: Develop specifications and process descriptions to provide the coatings for military and commercial applications.

COMMERCIAL POTENTIAL: These coatings will be suitable for civil aviation applications worldwide and should be commercially attractive to many engine OEM and after market companies.

N96-188 TITLE: Multivariable Integrator Windup Protection for Aircraft Fight Control System using Model Predictive Controller

OBJECTIVE: Develop Model Predictive Control (MPC) methods for solving the integrator windup problem of advanced flight control system using numerous control effectors.

DESCRIPTION: The design of advanced flight control systems for high performance aircraft is involving the use of numerous control effectors to satisfy mission requirements. Integrator wind-up protection is particularly critical with the short-take-off-vertical-landing (STOVL) control law design problem because the system is so often operating on limits (thrust and vectoring) in powered-lift flight. Complicating factors are (1) the compensators often have a large number of states and (2) the multivariable control law operates on numerous control effectors. Traditional methods of using single-loop-at-a-time protection by freezing the integrators are impractical when state and output variables are numerous and cross-coupled. This topic will investigate the use of a Model Predictive Control (MPC) approach for the design of a supervisory controller to satisfy the constraints on the input and output variables for Robust Multivariable Control (RMC) design. The MPC approach modifies the command inputs to the RMC controller in an optimal way to keep all the constraints satisfied. Since the disparity between the commanded inputs and the actual inputs to the aircraft are eliminated, no integrator wind-up problem occurs.

PHASE I: Show feasibility for using the Model Predictive Control (MPC) approach in the design of a supervisory controller to satisfy the constraints on the input and output variables for RMC design.

PHASE II: Develop, test and operationally demonstrate the MPC methods formulated under the Phase I SBIR effort.

PHASE III: Produce the MPC methods demonstrated in the Phase II effort. This will be the transition from development to application for major aircraft programs such as the F-18 E/F, V-22 and JAST. High-angle-of-attack control and maneuverability are important concepts for combat effectiveness of the new class of fighters such as F-18, F-22 and JAST.

COMMERCIAL POTENTIAL: The proposed MPC solution to the problem of integrator windup and controller tuning can be applied across-the-board to process control systems in diverse industries such as chemical, automotive, pulp and paper, metallurgy, manufacturing, electronics and biotechnology.

REFERENCES: MIL-STD-8785C and 9490

N96-189 TITLE: Development of a High Power Air-Cooled Clutch

OBJECTIVE: Develop and validate advanced concepts for high horsepower, air-cooled clutches.

DESCRIPTION: Air-cooled clutches offer significant weight savings compared to oil-cooled clutch designs as utilized in present and future aircraft propulsion systems. Weight savings directly translate to increased payload and/or range. Presently, risk associated with the use of air-cooled clutches is unacceptably high, due primarily to problems accommodating the high thermal heat loads generated during engagement and disengagement.

PHASE I: The contractor will characterize the state of the art in high horsepower, air-cooled clutch design, performance, and durability. Advanced concepts will be explored for several propulsion system configurations and missions, with special emphasis on thermal management. Preliminary designs will be developed with critical elements identified.

PHASE II: Validation tests will be developed and performed on critical design elements. Selected clutch concepts will undergo detailed design.

PHASE III: Advanced air-cooled clutch technology will be transitioned into existing helicopter component improvement programs or emerging short-take-off-vertical-landing (STOVL) development programs.

COMMERCIAL POTENTIAL: New high-power air-cooled clutch technology has direct applicability to aircraft landing systems.

N96-190 TITLE: Viscous Cartesian Unstructured Grid Generation

OBJECTIVE: To develop a computer code that will automatically generate, without user interaction, a viscous cartesian unstructured grid about arbitrary complex 3D geometries.

DESCRIPTION: One approach to generating unstructured grids about complex configurations for use in solving both the inviscid Euler equations of fluid dynamics and Maxwell's equations in electromagnetics, is to use cartesian unstructured grids to make a discrete field. The advantage of this approach is that, although the grid is book-kept as an unstructured grid, there is a high level of implicit structure, making grid generation and adaptation robust and automatic. For example, computational cells in 3D are always cubes, which are easily adapted by splitting a cell into 8 cubes. The adapted cells may be book-kept using an octree data structure, making the resulting data structure very amenable for parallel processing. The disadvantage is that using only cubes does not provide a layered body-conforming grid that would be capable of resolving the boundary layer flow for viscous fluid simulations. A novel approach already being used for the Euler equations is to generate a cartesian unstructured grid over a configuration by clipping the cubes that intersect the body surface, making the grid conform to the body. An extension to this concept, which would be suitable for viscous flow problems, would be to generate layers within the clipped body-conforming cells to resolve the boundary layer flow. This idea is called "level-distance cutting."

PHASE I: Generate a computer code that would be capable of generating a 3D cartesian grid with "level distance cutting" for simple configurations such as a wing. Demonstrate this capability by generating a grid and then solving for the flowfield using an unstructured Navier-Stokes method.

PHASE II: Improve the grid generator so that it is capable of automatically generating a 3D unstructured cartesian grid with level-distance cutting over arbitrary complex configurations such as the F/A-18E. Allow for the code to run in parallel and to be called from a parallel unstructured Navier-Stokes solver, and adapt the cubes in the inviscid portion of the flow as well as the viscous portions in the boundary layer. Include a highly accurate NURBS representation of the body surfaces to insure that adapted cells on the surface stay on the surface.

PHASE III: Develop a Graphical User Interface (GUI) to control the code and assess grid quality. Port the code, and make it efficient in speed and memory and run well on parallel computers.

COMMERCIAL POTENTIAL: The ability to automatically generate field grids over and within complex geometrical shapes would revolutionize aircraft design. Field grids are required to solve the equations of structures, fluids, and electromagnetics. Up to this point, the most demanding part of the process from a human interaction perspective is the handling of the geometry

and the generation of the computational grid. It can take up to a full man year to develop a suitable grid over a complete aircraft configuration for a detailed computational fluid dynamic analysis. An automatic grid generator would reduce the time to generate a field grid by an order of magnitude, thereby, allowing highly accurate aerodynamic, structural and stealth data very early in the design phase. Accurate information and for trade studies early in the design phase translates to a potential savings of billions of dollars in the life-cycle of a naval system, as well as marked improvements in system capabilities. In short, any company that would develop the capability to generate field grids automatically would dominate in the world military and commercial aircraft business.

N96-191 TITLE: High Lift Aerodynamics Shear Layer Transition Modeling

OBJECTIVE: To identify, incorporate into a Computational Fluid Dynamic (CFD) code, and then calibrate a turbulence model to be capable of accurately modeling laminar to turbulent shear layer transition for high lift military airfoil/wing configurations.

DESCRIPTION: State-of-the-art CFD methods are currently being exercised by industry and government in an attempt to predict the characteristics of high lift aerodynamic configurations. A recurring problem in both commercial and especially new military wing shapes driven by stealth requirements, is the lack of ability to predict the transition from laminar to turbulent flow in viscous shear layers. The result is a poor correlation with wind tunnel and flight data at carrier approach and maneuver conditions. Since wing leading edges for modern military profiles are typically sharp, the character of the resulting free shear layer plays an important role in predicting near stall and post-stall aerodynamic characteristics. Two-equation turbulence models have shown to be capable of modeling laminar to turbulent transition for a limited class of flows, namely, attached shear layers over a flat plate. This promising approach needs to be investigated for potential use on airfoil and wing shapes for attached and free symmetric and asymmetric shear layers.

PHASE I: Identify and incorporate into a 2D incompressible Navier-Stokes flow solver a turbulence model that has the potential of modeling laminar to turbulent shear layer transition. Then, use existing experimental data from recent detailed shear layer wake experiments, and modern military high lift airfoil experiments to calibrate the turbulence model for accurate modeling of attached and free shear layer transition, and turbulent boundary layer and wake development.

PHASE II: Incorporate the turbulence model developed above into a 3D incompressible Navier-Stokes flow solver. Moving from 2D to 3D is not straightforward, since by adding a third dimension, additional 3D fluid dynamic phenomena are introduced such as attachment line transition and re-laminarization, and 3D stretching of shear layers.

PHASE III: Incorporate the turbulence model into a 3D compressible flow solver that would be capable of efficiently modeling a realistic range of flow conditions from carrier approach (low subsonic) to high speed maneuvers in compressible flow regimes.

COMMERCIAL POTENTIAL: Commercial airframe companies working on conventional low speed aircraft as well as High Speed Civil Transport configuration options would benefit directly from any headway made in transition modeling. A tiny improvement in high lift capability is enough to dominate in the international aircraft business.

N96-192 TITLE: Aircraft Weapon Bay Turbulent Flow Simulation Model

OBJECTIVE: Develop a computational turbulent flow model to predict the flowfield in the aircraft internal weapon carriage bay area when complemented with the wind tunnel test to ensure the smooth store ejection process.

DESCRIPTION: A need exists to design fighter/attack aircraft which carries the weapon internally due to stealth considerations. In order to deliver these internal-carried weapons smoothly, a methodology has to be developed to predict the complex turbulent flow in the weapon bay area with strong velocity gradient and unstable flow field to reduce very expensive wind tunnel tests. Fortunately, the recent development of numerical algorithms and computer hardware indicates that computational fluid dynamics techniques are mature enough to calculate this complicated flow phenomenon. Nevertheless, a sufficient accurate turbulent model still has to be developed so that the flowfield can be predicted quantitatively for practical design evaluation purposes. The model shall be able to describe the flowfield under the fuselage within the weapon bay area including the imbedded weapons at mach numbers between 2. and 0.2. to ensure clear weapon separation.

PHASE I: Provide a turbulent model with corresponding flow solver to compute the flowfield in the weapon bay area with imbedded weapons.

PHASE II: The method is expected to be extended to include the prediction of transient flowfield during the opening of the bay door for weapon separation.

PHASE III: Model will continue to be extended to predict flowfield of future modifications.

COMMERCIAL POTENTIAL: Modeling/simulation can be used for industrial turbulent flow prediction, for example, aircraft/helicopter noise level reduction prediction, jet flow prediction, etc.

REFERENCES:

1. N.E. Suhs, "Computations of three-dimensional Cavity Flow at Transonic Mach Numbers" AEDC TR 88-30
2. S.M. Dash, H. Sinha, etc., "Progress in the Unsteady Simulation of Jet Flowfields" AIAA-93-1921, AIAA/SAE/ASME/ASEE 29th Joint Propulsion Conference, June 1993, Monterey, CA

N96-193 TITLE: SYSTEMS ENGINEERING ENVIRONMENT: Methods and Tools for Collaborative Systems Engineering at Geographically Distributed Sites

OBJECTIVE: To investigate processes, methods, and tools that would improve efficiency and accuratcy of system engineering. It is envisioned that system engineering will be performed in a collaborative manner by personnel located in geographically dispersed sites using a variety of heterogeneous computer resources. This research will investigate the relationships between current system engineering processes and the methods and tools that could be used for improvement. Particular research will be required to explore mechanisms to adapt method-intensive software tools to extant system engineering processes.

DESCRIPTION: DoD has a severe problem with system engineering. The problem is compounded by the increasing complexity of weapon systems and the economic demands for increased productivity in labor-intensive disciplines. This intensive work is done by individuals, single groups, and multiple groups, depending on project requirements. Current approaches use manual, informal, system engineering methods and processes that require large amounts of manpower and yet, at the same time, are subject to error because of the inherent complexity of the systems. Approaches are needed that integrate information processing and communications to support the guiding systems engineering processes while improving overall group productivity. This research delves into system engineering process and explores, devises, and develops useful tools. Of particular interest are solutions that support not only the mode where work groups function at the same time (synchronous mode), but also when the groups function at different times (asynchronous mode).

PHASE I: Research and analysis of prototypical system engineering to determine their potential usefulness. This feasibility investigation will result in a clearly defined direction in which to pursue further system engineering automation.

PHASE II: Analysis and integration of current NAWCAD and TEAM system engineering processes to further research into modifying them to work collaboratively with new methods (locking, security, transport) and computer based tools. Development of requirements for a full scale computer based System Engineering Environment. Coordination and cooperation with Rome Laboratories Advanced System Engineering Automation (ASEA) project, and Dr. David Hsiao's database work at the Naval Postgraduate School (NPS) will be essential.

PHASE III: Complete application of the International Council on System Engineering's (INCOSE) software process concepts to TEAM's distributed system engineering process. Further coordination with other efforts will be initiated and/or continue.

COMMERCIAL POTENTIAL: System Engineering practice is currently supported by very few automated tools. Those that are used are typically single user or single site. Providing distributed automation tailored to specific user domain needs has great potential for most mid-size to large corporations involved with system engineering activities.

N96-194 TITLE: Innovative Control Design Impact for Aircraft

OBJECTIVE: Conduct a design impact study on how innovative aircraft control effectors can influence metrics such as cost, size, weight, producability, reliability/maintainability (R&M) and life cycle cost (LCC) of aircraft for both commercial, general aviation and military use.

DESCRIPTION: The necessity for aircraft in all areas of aviation to perform their mission in a cost effective manner while incorporating new and more challenging design requirements has resulted in the need to identify innovative design concepts that could effectively influence the cost, size, weight, producability, R&M and life cycle cost of operating the vehicle. Many design concepts are being explored for more universal implementation such as vortex flaps, thrust vectoring, canards, nose stakes/doors, etc., but have not 'earned' their way on aircraft because limited design impact studies have been done to see how

these concepts can replace 'conventional' controls or downsize the vehicle.

PHASE I: Identify candidate control effectors for aircraft that can have a direct influence on the cost, size, weight, producability, R&M and LCC. Conduct a parametric study showing each of these controls versus each metric and how they influence the design in either a positive or negative way, or how they can be used in combination with other controls to affect the aircraft design. Show examples with existing aircraft of how positive candidate effectors could improve the design metrics without compromising the mission effectiveness of the vehicle. Propose experiments/tests or simulations for Phase II that could quantify these benefits to air vehicles. Consideration must be given to any effected subsystem and how this subsystem will be accounted for in terms of reliability if the supporting system is now a prime control effector. As an example, if thrust vectoring is assessed, show how the reliability of the engine is accounted for now that it supports a primary flight control. Consideration must also be given for vehicles that have low observability requirements and how these innovative controls factor in to a design with this additional challenge. Center of gravity influence on control design and design philosophy must also be addressed. All experiments/tests and/or simulations proposed for Phase II must specify what parts are GFE (i.e. government owned wind tunnel facilities, wind tunnel models, flight simulators, design tools, etc.) and what parts are funded within the $750K Phase II limit. The offeror may not propose a Phase II effort that requires additional government funding to secure the use of non-government owned test resources.

PHASE II: Conduct wind tunnel tests on candidate aircraft (to be supplied GFE or built as part of this effort) to acquire data to validate the parametric study developed in Phase I. This validation shall be done by incorporating the results of these tests into a flight simulation showing the comparison of a baseline flight control effector systems with an innovative design concept. Conduct additional experiments/tests/simulations, as necessary, to fully substantiate the improvements of the innovative design over the baseline aircraft as a function of the design metrics specified in Phase I. Develop software that can be utilized to conduct these parametric studies on any aircraft in order to assist designers in making critical design decisions that will positively influence aircraft design. Provide design recommendations tailored to commercial, general and military aviation.

PHASE III: Produce the software and design parametrics that can be utilized by all areas of aviation to support the aircraft design process. Ensure the product can be readily utilized by commercial, general and military aviation. Ensure the software has flexibility incorporated to accept future innovative design concepts not considered or considered infeasible during this study, but is developed at a later time.

COMMERCIAL POTENTIAL: Significant commercial potential exists since all areas of aviation are challenged to produce an air vehicle that can effectively complete its design mission in a cost effective manner. The incorporation of any innovative control effector will be a direct result of its value when compared to the design metrics of this study. General and commercial aviation designers are always in search of new methods of producing a profitable vehicle. Innovative control effectors can directly influence these potential profits.

N96-195 TITLE: Escape System Data Recorder

OBJECTIVE: Design and fabrication of an on-board data recorder applicable to ejection seats.

DESCRIPTION: An on-board data acquisition system is needed to enable quantitative analysis as opposed to qualitative assessments of aircrew mishaps. The resulting data shall begin a detailed engineering data base of aircrew escape mishaps. To fully evaluate the ejection seat performance, full six-degree-of-freedom motion must be measured and stored, from just prior to the ejection until surface impact. The data system should be small, light-weight, and self-contained. Issues such as power supply, sensors, start indicator, storage device, electromagnetic interference, and generic attachment to the seat system shall be considered.

Additionally, this data recorder could be used to accurately determine the acceleration levels to which the aircrew are being exposed, thereby providing accurate human tolerance levels, and enabling a database for the percentage of risk associated with acceleration level.

PHASE I: Provide research, analysis, initial design, and bread-board mockup for the data recorder system.

PHASE II: Detailed design and fabrication of light-weight system prototypes.

PHASE III: Integration of the system in ejection seats.

COMMERCIAL POTENTIAL: Automotive crash systems and commercial aircraft application.

REFERENCES: MIL-S-18471G

N96-196 TITLE: Hot Film Sensing of Vortex Shedding and Structural Dynamics

OBJECTIVE: To develop the capability of 1)using hot film sensors for sensing the frequency of vortex shedding and breakdown in vortical flows, and 2) correlating the frequency of vortex shedding with the resulting harmonic structural dynamics of aerodynamic surfaces such as wings, flaps, and vertical or horizontal tails.

DESCRIPTION: The use of hot film sensors and anemometry has recently become available for sensing Critical Aerodynamic Flow Feature Indicators (CAFFI), such as laminar to turbulent transition, and attachment and separation points. This new flow diagnostic technology is non-intrusive to the flowfield and has been demonstrated in wind tunnel and flight tests. Development of a system capable of monitoring the frequency of vortex shedding and breakdown and the structural response of aerodynamic surfaces in real time is the first step in developing a closed loop feedback control system for alleviating undesired structural responses. This approach solves the structural fatigue problem experienced by modern flexible airframes by determining its original fluid dynamic source, as opposed to merely adding strength, and therefore weight, to the airframe.

PHASE I: Test a generic double-delta wing with rigid and flexible vertical tails in a wind tunnel. Instrument the leading edges of the wing, the upper surface, and the vertical tails with multiple arrays of hot film sensors. Acquire real time data to determine the correlation between time dependent leading edge shear layer instabilities, vortex breakdown, and aerodynamic surface structural harmonics.

PHASE II: Conduct a wind tunnel test on a realistic aircraft configuration for which there exists flight data, such as the F/A-18C.

PHASE III: Develop a stand-alone real-time hot film system, consisting of sensors, anemometers, and software and hardware that could be used in wind tunnel testing, flight testing, or as an input to a flight control system on an aircraft.

COMMERCIAL POTENTIAL: The use of vortical flows in commercial designs is increasing. The High Speed Civil Transport (HSCT) configurations and the Space Shuttle all rely solely on vortical flows for low speed maneuvers, take-off (HSCT only) and landing. Improvements in understanding and modeling of these flows will have a direct benefit to the commercial market.

N96-197 TITLE: Advanced Scanning Interferometer System for Characterization of Moving Surfaces.

OBJECTIVE: To develop a compact and portable full field interferometer for measuring periodic deformation of surfaces of ultrasonic transducers and other motion sensors and actuators. The unit should be capable of full field imaging at variable resolution (50x, 100x, 200x) with high vertical sensitivity (vertical displacement resolution < 1 nm) at nearly real time (10 sec or less for data acquisition plus around 30 sec or less for data processing). The unit should also image vibrating surfaces at frequencies ranging from 100 Hz too 100 Mhz. The full vibrating surface should be displayed immediately after the imaging process.

DESCRIPTION: With the development of new micro-electro mechanical systems (MEMS), advanced ultrasonic transducers, accelerometers, steering arrays,.LED's and other motion transducers, the need for motion inspection is critical for rapid design validation. Present motion inspection systems are slow, large, requiring expensive vibration isolation equipment, with limited spatial and vertical resolution and limited spectral band spatial. This effort will significantly improve the inspection (and therefore the quality) of these new and advanced devices that are of critical importance to present and future DoD needs as well as in the civilian sector.

PHASE I: A proof of concept will be performed. The prototype system will have to image in full field and in near real time (less than a minute for data acquisition, data processing and displaying results) the surface displacement of the sensor or actuator. The prototype system should be capable of imaging surfaces that vibrate from 100 Hz to 10MHz.

PHASE II: In phase II the a complete system will be developed. The system should be desk-top based (preferable portable), with an optional sample vibrating stage for inducing mechanical oscillations in the sensor under study. The optical delivery system should allow for the use of different objective lenses (50x, 100x, 200x) as well as the capability of allowing the operator to view the surface being tested via a TV monitor through a CCD camera.

PHASE III: This inspection tool could be modified for quickly testing other transducers, heat sensors, and sonar applications.

COMMERCIAL POTENTIAL: This device can be used for the development and inspection of various transducers used in the civilian sector such as ultrasonic transducers used in automotive (intelligent damping) and commercial aviation industry.

N96-198 TITLE: Wire Bonding Interconnects for High Temperature Silicon Carbide Electronics

OBJECTIVE: Development of a wire bond interconnect for silicon carbide semiconductor devices with survivability at 500 C.

DESCRIPTION: Semiconductor devices are currently being manufactured from a new semiconductor material - single crystal silicon carbide - that can withstand operating temperatures of 500 C. However, present-day wire bonding technology only allows operation up to temperatures of 200 C. Current wire bonding technology (generally consists of gold wire bonds) does not have the capability to survive elevated temperatures (500 C) for extensive periods of time without failure by several mechanisms which include corrosion, oxidation, intermetallic formation and metal creep. The objective of this SBIR will be for a small business to research, formulate and devise a high temperature bonding technology that will survive the rigors of a 500 C environment.

PHASE I: Determine the scientific feasibility of producing a high temperature wire bonded interconnect for SiC semiconductor devices. The study will require a historical and scientific assessment of present high temperature interconnect technology and its potential application to SiC devices. The efforts will also include the conception of new bonding materials/alloys and techniques to be used in high temperature systems. The suggested new wire bonding technology must be targeted specifically for use in new silicon carbide devices and engineered such that material and device operation incompatibility does not exist. The Phase I study will also provide an assessment of conventional wire bonding failure mechanisms and the potential for such mechanisms to cause failure of the conceived bonding technology. Methods to prevent such failure mechanisms from occurring will also be required.

PHASE II: Develop prototype wire bond specimens that will be subjected to high temperature exposure and temperature cycling. Aspects such as material compatibility, corrosion resistance, void formation, intermetallic formation and ohmic contact degradation will be ascertained after exposure to temperature. It is envisioned that, at least three different new high temperature bond wire interconnects will be evaluated.

PHASE III: Incorporate Phase II results in the silicon carbide device manufacturing.

COMMERCIAL POTENTIAL: The wire bond interconnect technology is not limited to military utilization. Silicon carbide devices will be utilized in any systems that demand survivability in high temperature and high power applications. Commercial applications include high temperature automobile sensors, deep well drilling applications, and jet engine/gas turbine applications. Military applications include high-temperature engine sensors and high-power microwave systems as well as power supplies, and radiation hard applications.

REFERENCES: Transactions, Second International High Temperature Conference, June 5-10, 1994, Charlotte North Carolina

N96-199 TITLE: System and Algorithm Concepts for Automatic Detection and Classification of Non-Traditional Acoustic Signals

OBJECTIVE: Develop and demonstrate signal processing algorithms and display/MMI concepts which exploit non traditional sound sources in an Airborne ASW platform environment.

DESCRIPTION: The Navy Airborne ASW acoustic detection and classification systems have relied on traditional signal types for passive detection, classification, and tracking of enemy submarines. The change in the projected threat and areas of operation have shifted the primary mode of air ASW to active. This SBIR effort will capitalize on existing non traditional target sources which may be used to complement the primary active modes planned.

PHASE I: Provide innovative signal processing and system concepts which will operate in an adjunct mode for the detection, classification, and tracking of non traditional passive signals. The concepts must demonstrate sufficient performance metrics of detection and false alarm probabilities to add value to the planned airborne ASW systems, as well as feasible system implementation.

PHASE II: Develop, test, and operationally demonstrate the Phase I concepts using actual data in a prototype system. The test and demonstration may include both laboratory and flight tests. The prototype system must be consistent with transition of the concepts to fleet systems.

PHASE III: Implement the system concepts and algorithms in a fleet ASW platform configuration.

COMMERCIAL POTENTIAL: The concepts can be used as adjunct sonar processing in commercial surface craft or special military aircraft for the monitoring of sea life or for detection of water-borne sounds in emergency situations.

N96-200 TITLE: Integrated Flight Performance Model for Various Aircraft Platforms

OBJECTIVE: To investigate the feasibility of developing the flight performance models for various aircraft platforms into one integrated system such that the effort of the future insertion of a new aircraft platform into the system is minimized.

DESCRIPTION: Tactical Aircraft Mission Planning System (TAMPS) is an interactive computer graphics system supporting aircrew oriented mission planning for U. S. Navy and Marine Corps airborne weapon systems. In order to support various aircraft platforms and weapon system requirements while maintaining consistent displays, user interfaces, and a common database, a set of core modules satisfies common planning requirements is provided. The core serves as a basis for integration of independently developed Mission Planning Modules (MPMs) supporting unique requirements. Each MPM supports valid flight maneuvers including military power climb, climb/cruise at optimum altitude, cruise/climb at optimum hemispheric altitude, best range cruise at specified altitude, normal descent, etc. There are commonalties in the flight maneuvers that are shared by each MPM. If there is a way to implement a super set of flight maneuvers in the TAMPS core so each MPM is able to use the required flight modes readily provided by the core, it could eliminate the need to design, implement and test the flight maneuvers for each MPM. Certainly this will reduce the cost of producing a MPM for each specific aircraft platform.

PHASE I: Research and analyze of Flight Performance Models for various aircraft platforms to determine their potential commonality and reusability. Initial study should use one aircraft from each type of aircraft platform (fighter, helicopter, cargo, EW, ASW, etc.).

PHASE II: Develop a prototype based on the result of Phase I analysis to demonstrate the feasibility of having one integrated flight performance model that supports many different aircraft platforms.

PHASE III: Incorporate improvements into TAMPS and future aircraft mission planning systems.

COMMERCIAL POTENTIAL: Potential use to other Government agencies, especially Air Force and Navy, as well as to the private sectors who need to reduce the software development cost and explore the reuse technology.

REFERENCE: DoD Flight Performance Module Interface Control Document, Version 2.0.2, September 1994.

N96-201 TITLE: Using Multi-media for embedded Training within Application Software

OBJECTIVE: To develop a package that will allow application software developers to easily embed multi-media based training within their products.

DESCRIPTION: One of the major complaints within the Fleet today is insufficient training for the application software that has proliferated into the Fleet. This software is under constant change. Staff personnel are in frequent rotation, and there is a lack of funds and time to keep re-training fleet personnel in the software's operation. This has led to a demand for some kind of embedded software training. Using multi-media to accomplish this training will increase the effectiveness of such training, provide fleet personnel with interactive-feedback training, and enhance utilization of the application software.

PHASE I: Investigate various methods of doing embedded training using multi-media. Develop an approach for a generic embedded training tool that will allow application developers to provide training as a portion of their application. Write a report detailing the methods investigated, the approach developed, and reasons for the choice.

PHASE II: Implement an embedded training tool based on the work in Phase I. Use an X-Windows / Motif based system such as Joint Maritime Command Information System (JMCIS) as a target test platform and application.

PHASE III: Generalize the tool developed in Phase II for multiple Hardware/Software based platforms.

COMMERCIAL POTENTIAL: With the increase in complexity of commercial software products, embedded training would reduce software support costs, eliminate training video production costs, and potential increase sales due to having a more complete software product.

N96-202 TITLE: A POSIX Interface for the F-22 Common Integrated Processor Avionics Operating System

OBJECTIVE: To determine the extent to which the Avionics Operating System (AOS) for the F-22 Common Integrated Processor (CIP) can offer a POSIX conforming Application Program Interface (API) for its services.

DESCRIPTION: The Joint Advanced Strike Technology (JAST) program seeks to reap the benefits of open systems technology

by utilizing POSIX conforming interfaces to its operating system(s), thereby realizing increased software portability, interoperability, and reusability over the life cycle of the program. However, the program also seeks to maximize software reuse and minimize development cost and risk by using a proven operating system implementation which already provides fault tolerance and security policies appropriate for embedded military avionics software: namely, the AOS produced by Hughes Aircraft Company for use in the CIP aboard the F-22 aircraft.

The AOS provides an Ada-language API to its services, but that API is currently not POSIX conforming. Research is needed to determine the mapping between the services provided by the AOS and a set of POSIX conforming interfaces. The goal of this research would be a modified AOS with complete conformance to an appropriate POSIX profile, yet retaining most of its original design and implementation. Such an operating system implementation would satisfy both JAST program goals in a timely and cost-efficient manner.

PHASE I: Phase I will partition and compare the functionality of the AOS with the underlying functionality implied by POSIX APIs; all POSIX APIs will be considered: those which are already IEEE and/or ISO standards, and those which are still draft standards; regardless of whether or not Ada bindings to those APIs and draft APIs are currently available. Those APIs deemed inappropriate for embedded realtime avionics applications will be eliminated from the profile and from future consideration. The goal is to identify three areas:(1)The intersection: where POSIX interfaces provide access to AOS services in a relatively straightforward manner. This is not likely to be a simple one-to-one mapping; a paradigm shift is anticipated, but the underlying functionality of AOS can generally be utilized to support the POSIX interfaces. (2) Unsupported POSIX APIs: Those POSIX interfaces (appropriate to the specified embedded realtime avionics profile) which are not supported by any underlying AOS functionality. (3) Unsupported AOS functionality: Those AOS services which cannot be accessed through any POSIX conforming interfaces.

A large intersection with minimal unsupported APIs and functionality would justify continuing this effort into Phase II. Unsupported AOS functionality so identified should be transitioned to POSIX as a new Ada Bindings project with the AOS Software User Manual as its base document.

PHASE II: During phase II, proof of concept, the contractor will produce a thin layer of software utilizing existing AOS APIs to provide a POSIX conforming API environment. An representative F-22 subsystem or sub-application will be redesigned and recorded to use the POSIX APIs. For AOS functionality that is inaccessible through the POSIX conforming APIs, existing AOS APIs will be retained, but no AOS API will be used which provides a service accessible via POSIX conforming APIs. The resulting application shall be tested and its performance evaluated while operating with AOS and the contractor developed software layer. Where performance degradation is detected, the contractor will determine if such degradation is merely the result of the redundant software layer, or can be directly attributed to inefficiency caused by using the POSIX APIs. Success will be measured by percentage of the application which can be written as a strictly conforming POSIX application, and the relative performance of the redesigned application with respect to the application interfacing directly to AOS via its native APIs. The contractor will support an Ada Bindings amendment (for APIs to support AOS unique functionality) within the POSIX standards process, and attain the status of a draft standard.

PHASE III: Phase III involves integration of the POSIX conforming interfaces directly into AOS, either completely replacing its native APIs or offering an alternative API set. This phase would eliminate the performance degradation associated with the additional mapping/binding software layer, and yield a production quality implementation of AOS with POSIX bindings. Because this implementation would be required to support the unsupported POSIX APIs identified during Phase I, the implementation may need to be augmented with additional functionality so that other applications (including reusable software components) conforming to the specified POSIX embedded realtime avionics profile would be fully supported. By this phase, a POSIX project to amend the POSIX Ada bindings to support all the AOS functionality should be well underway, there should be little, if any, need for nonstandard APIs.

COMMERCIAL POTENTIAL: By demonstrating that the DoD is serious about its commitment to POSIX interfaces, and that such interfaces are applicable to non-traditional-UNIX applications such as avionics and weapons systems, commercial vendors of realtime kernels and operating systems targeted to other military and non-military application domains would be encouraged to provide implementations with a POSIX conforming interface, thereby increasing the market for their products while expanding support for the open systems concept in the commercial sector.

REFERENCES:
1. Software User Manual for the Avionics Operating System of the F-22 Common Integrated Processor, Hughes Aircraft Company;
2. IEEE PASC standards and draft standards from the POSIX project;
3. POSIX Delta Document for the Next- Generation Computer Resources (NGCR) Operating Systems Interface Standard Baseline, SPAWAR-331.

N96-203 TITLE: Incremental Modernization of Legacy Software Systems(IMLSS)

OBJECTIVE: Define processes and develop technology that supports the incremental modernization of large scale legacy software systems.

DESCRIPTION: The DOD has deployed many large scale software systems over the last two decades. Most of these software systems are still in use and have been continuously repaired, enhanced, and maintained since deployment. These software systems are frequently based upon obsolete technologies (e.g., operating systems, languages) and cannot be modernized to current technologies due to cost. If processes and technology existed that allowed modernization in a cost effect manner, the life cycle of these software systems could be significantly extended. Processes and technology are needed that will allow modernization of large scale software systems in smaller, incremental steps. Of special interest are processes and technologies that can handle obsolete operating systems, outdated source code, improve understanding of the software and associated documentation, improve maintenance through reuse libraries, improve testing by use of simulation, and provide new methods for utilization, scheduling and optimization of distributed computer resources.

PHASE I: Identify processes to be established. Show the impact on current development and maintenance processes. Study, analyze, document, and prioritize innovative technologies for incremental modernization of large scale legacy software. Identify benefits and risks of using these technologies.

PHASE II: Provide a prototype demonstration of the feasibility of incrementally modernizing large scale legacy software.

PHASE III: Having shown feasibility, apply the techniques to candidate systems. Examples include but are not limited to the SH-60B and S-3B.

COMMERCIAL POTENTIAL: The commercial potential is high. Many commercial software systems face the problem of converting legacy software to new technologies. IMLSS processes and technology can be used to economically convert existing software systems to improved software systems that use current technology.

N96-204 TITLE: Transitioning Embedded Avionics Software from Ada 83 to Ada 95

OBJECTIVES: Conduct research to determine the feasibility, pitfalls and benefits transitioning existing DOD programs to Ada 95.

DESCRIPTION: The introduction of Ada 95 presents the DOD with a powerful new tool for implementing their software systems. The combination of its modern software engineering features, along with the reliability, safety, and maintainability of Ada 83, make the new version of the language a viable technical option for any domain. Even though Ada 95 is designed to be a robust superset of Ada 83, past experience dictates there will be risks in the transition. Experience also dictates that transition is also inevitable as support for Ada 83 dies off.

PHASE I: Phase I will result in the selection of an existing embedded avionics system that meets the following criteria: At least 85% of the code must be written in Ada 83, the system should be of medium size (25 KLOC to 100 KLOC), and the compiler vendor that supplies the Ada 83 compiler system must provide an Ada 95 version of the same compiler system. A set of metrics shall be identified and collected for both the Ada 83 system and the transitioned Ada 95 system. Examples of metrics to be collected are executable code size, system throughput, design, code and test hours, etc. The existing Ada 83 system will be rebuilt in Ada 95, and the Ada 95 code will be tested utilizing the existing test procedures developed for the Ada 83 system. Products of phase I will include Ada 95 source code, a software test report, a technical paper detailing results and lessons learned from the transition, and detailed project plans for Phase II.

PHASE II: Phase II will result in the redesign of the system selected during Phase I. The redesign of the system will be implemented in such a way as to: (1) maximize use of the new Ada 95 features in new/future modifications, (2) maximize the integration between old Ada 83 data structures and new Ada 95 data structures. Metrics identified and collected during phase I will again be collected for the redesigned system, and the new system will be tested utilizing the same test procedures as used for Phase I. Products of phase II will include Ada 95 source code, a software test report, and a technical paper detailing results and lessons learned from the transition.

PHASE III: During phase III, the system will be released for project use and applied to other embedded systems.

COMMERCIAL POTENTIAL: Ada 83 is not strictly a DOD programming language. Both Boeing and Rockwell-Collins use Ada 83 for their commercial avionics applications, and Weirton Steel utilizes Ada 83 in their plant process control system. Ada 83 will be used in NASA's Space Station's Software Support Environment, the on-board data systems, the ground data systems,

and all robotics and flight software. Any of the agencies listed above, as well as, any other agency using Ada 83 technology, can benefit from the results of this research.

REFERENCES:
1. Ada 9X Transition Planning Guide, Version 1.0
2. Ada 9X Adoption Handbook
3. Ada 95 Language REFERENCE Manual

N96-205 TITLE: Adaptive Optics for Advanced Laser Systems

OBJECTIVE: Provide a correction for laser beam distortion by atmospheric turbulence in airborne, laser-based infrared countermeasures (IRCM) systems laser rangefinders (LRF), and laser target designators (LTD). The goal is to increase the fluence on a target by an order of magnitude under turbulent conditions.

DESCRIPTION: Tri-service efforts are currently under way to develop laser based countermeasures systems to defeat advanced heat seeking missiles. However, atmospheric turbulence in the boundary layer surrounding the aircraft causes a significant reduction in laser radiance (brightness). The laser power must be increased to compensate for the loss in radiance due to atmospheric turbulence. Adaptive optics has been successfully developed for use in large astronomical telescopes to compensate for atmospheric distortions. A decade ago, adaptive optics with deformable mirrors and wavefront sensors, was considered to be an exotic technology. New interest in dynamic beam quality control for industrial applications such as precision laser welding has stimulated interest in developing simpler adaptive optics components and software. This effort seeks to develop innovative adaptive optics components and techniques for use in Navy airborne advanced IRCM systems, LRFs and LTDs.

PHASE I: Conduct a feasibility study which defines practical and affordable system concepts based on adaptive optics technology for correction of laser beam distortion by atmospheric turbulence. The feasibility study will include the following areas: (a) estimate turbulence effects on laser system performance; (b) investigate various beacon options; (c) define an advanced adaptive optic component concept; and (d) define an advanced adaptive optic system configuration. The end product is a technical report describing the adaptive optic concept and estimated performance.

PHASE II: Design, build and test brassboard adaptive optic system based upon the concept defined in Phase I for use in advanced laser based IRCM and precision targeting systems.

PHASE III: Produce a fieldable adaptive optic system, which will be integrated into Navy airborne IRCM and precision targeting systems.

COMMERCIAL POTENTIAL: New affordable adaptive optics components including wavefront sensors can be used in industrial precision laser welding and processing systems.

REFERENCES:
1. L. E. Schmutz, "Adaptive Optics Comes of Age", Lasers & Optronics, pages 25-26 (Dec 1994);
2. R. Q. Rugate and W. J. Wild, "Untwinkling the Stars - Part I", Sky & Telescope, pages 24-31 (May 1994)

N96-206 TITLE: Laser Beamrider Detection

OBJECTIVE: Develop a fiber optic coupled laser warning sensor capable of detecting and locating laser beamrider (LBR) weapon's systems targeting Navy aircraft.

DESCRIPTION: Laser warning sensors, such as the AN/AVR-2 have been installed on Navy and Marine Corps helicopters to protect against weapon's systems using laser rangefinders and laser target designators. Fiber optics coupled laser warning sensors have been developed for use on high performance aircraft. These laser warning sensors (LWS) provide laser detection, angle of arrival, wavelength discrimination and temporal characterization of the laser source. However, these laser warning devices are not sensitive enough to detect and characterize laser beamrider weapon's systems. This effort will develop a fiber optic coupled laser warning sensor for detection of LBR weapon's systems operating in the near infrared spectral range (.75 to 1.1 μm).

PHASE I: Provide a feasibility study, which demonstrates the sensitivity required for LBR detection in the near infrared spectral range using a fiber optics coupled laser warning sensor. The end product is a report defining the LWS concept, the laboratory demonstration and final system configuration. The LWS shall provide LBR detection and information on angle

of arrival, pulse width and pulse repetition frequency (PRF).

PHASE II: Develop and test a brassboard fiber optic coupled LWS based upon the concept demonstrated in the Phase I effort.

PHASE III: Produce the fiber optic coupled LWS demonstrated in Phase II for use on Navy and Marine Corps aircraft.

COMMERCIAL POTENTIAL: There is a need for laser radiation warning devices, especially for "invisible" infrared lasers used in medical diagnostics, surgery, industrial processing and welding, and in research applications. The high power laser market for medical and industrial applications is growing at the rate of 9000 lasers per year.

REFERENCES: S. M. Hardy, "Taking Threats Too Lightly?", Electronic Defense, Vol. 16, No. 10, pages 47-52 (October 1993).

N96-207 TITLE: High Brightness, Wavelength Selectable, Pulsed Solid-State Laser Sources.

OBJECTIVE: Develop, compact, high brightness, pulsed solid state laser sources in the 1.5 to 10 micrometer (μm) wavelength range.

DESCRIPTION: Current techniques for generating medium-pulse energy eyesafe-radiation use nonlinear-optical processes that can be efficient and compact, but have a poor optical beam quality. For many military applications, medium pulse energy with good beam quality in a simple, compact, rugged package is highly desirable. Some of the applications include airborne surveillance, target tracking and discrimination for theater missile defense, and remote sensing. Innovative approaches for the development of wavelength selectable solid state laser sources in the eye safe wavelength range of 1.4 to 2.5 μm are sought. The proposed technology should emphasize medium single pulse energy (> 500 milli-joules) with near diffraction limited beam quality. For Navy airborne applications, the proposed technology should lead to laser devices, which are compact, lightweight, efficient and reliable at an affordable cost.

PHASE I: The goal is to determine if the proposed concept is viable for airborne applications in terms of size, efficiency, and wavelength selectivity. If feasible, a breadboard prototype will be built and demonstrated. The end product of Phase I is a report describing the approach to generate > 500 mj laser pulses at a pulse repetition frequency (PRF) of greater than 50 Hz in the eyesafe wavelength range (selectable) with near diffraction limited beam quality.

PHASE II: Develop and test a brassboard high brightness, eye safe laser source with near diffraction limited beam quality.

PHASE III: Produce engineered production models of the laser source developed in Phase II for commercial and military systems.

COMMERCIAL POTENTIAL: Laser sources in the 1.4 to 2.5 μm range have commercial applications including lidars for wind shear and turbulence detection, gas leak detection, pollution monitoring, surgery and materials processing.

N96-208 TITLE: Unmanned Aerial Vehicle(UAV) Low Probability of Intercept (LPI) Communications Relay and Interrogator for the Search and Rescue Beacon Transponder

OBJECTIVE: Develop a low probability of intercept UAV communications relay and interrogator for the search and rescue beacon transponder

DESCRIPTION: Future military operations involving highly mobile forces ashore will require communications that must be flexible and reconfigurable to meet rapidly changing command and control requirements. Deployment time, terrain limitation, distance, responsiveness, and survivability will heavily tax the capabilities of available communication assets. The UAV based communications relay system can provide a cost effective, re-usable and flexible means of connecting widely dispersed tactical units and individuals.

The UAV LPI communications relay/interrogator will be used for range extension between the Services's LPI communications radios in support of the covert operation and highly secure military communications. It will serve a communication range extension assets when satellite communication is not available and when the manned airborne communication asset is not operationally viable.

Through sharing of common hardware and programmability of the embedded software, a combined LPI radios relay and

search and rescue beacon transponder interrogator can be built to fit on the UAV. This same communications relay will serve as the airborne interrogator to quickly locate the downed airmen or contact the special forces to ascertain their precise position for rendezvous and pick-up, when they are suitably equipped with the Services' standard survival radios. PHASE I: Investigate the adaptation of LPI communications relay and search and rescue beacon interrogator technology for UAV applications. Conduct a feasibility study and perform architecture definition, technology trades and requirements analysis.

PHASE II: Develop prototype hardware, and demonstrate a UAV based LPI communications relay and search and rescue beacon interrogator system which must be low cost and easy to deploy.

PHASE III: Produce the complete UAV LPI communications relay/interrogator system for operational testing.

COMMERCIAL POTENTIAL: The UAV LPI communications relay/interrogator system can be used by the law enforcement agency and counter narcotic operations.

N96-209 TITLE: Unmanned Aerial Vehicle(UAV) Based Magnetic Anomaly Detection (MAD) for Small Submarine Hunting in Shallow Water and Over-the-Land Reconnaissance

OBJECTIVE: Develop a low cost/lightweight UAV MAD sensor suite for shallow water submarine detection and land surveillance

DESCRIPTION: Naval expeditionary warfare requires our amphibious and naval fire support ships to operate ever closer to the hostile shore for extended period. World-wide proliferation of small diesel submarines operating in and out of small inlets and in shallow waters can pose serious threats to our forces. The traditional detection methods against those threats, i.e., periscope detection using inverse synthetic aperture radar, or sonar have inherent shortcomings when operating in a land clutter dominated environment and in shallow water. High valued naval aviation assets used to hunt down those elusive threats suffered undue risks in prolonged exposure while operating very close to the hostile territory. UAV based MAD payload can be a cost effective way to screen and localize the shallow water submarine threats prior to handing off those targets to other combatants for further prosecution.

Another critical aspect of the naval expeditionary warfare problem is the location of high valued concealed targets, i.e., underground reinforced command and control bunkers and concealed aircrafts and missiles concrete shelter which can be hard to locate and kill. Also the extensive use of covered revetments for tanks and artillery evident in the last regional conflict can pose great risk to our ground combat teams upon contact unexpectedly. EO/IR and radar surveillance sensors have inherent limitation in ferreting out these underground threats. UAV MAD payload combined with advanced signal processing techniques can be a powerful adjunct in marking out these high priority targets for later destruction.

UAV sized MAD sensor is expected to be highly sensitive to detecting any local variation of the earth's magnetic field due to the presence of an embedded mass of steel and concrete structure and in locating small submarines in shallow water. Equipped with GPS based navigation, the UAV MAD can map a large area and report the presence of any hidden targets through the enhanced signal processing technique and report the target location.

PHASE I: Investigate the adaptation of a lightweight MAD sensor and signal processing technology for UAV applications. Conduct a feasibility study and perform architecture definition, technology trades and requirements analysis.

PHASE II: Develop prototype hardware/software, and demonstrate a UAV based MAD system which must be low cost and easy to deploy.

PHASE III: Produce the complete UAV MAD sensor suite for operational testing.

COMMERCIAL POTENTIAL: The UAV MAD sensor suite can be used to for commercial geoprospecting and civilian remote sensing applications.

REFERENCES: UAV Master Plan 1994, available from the Naval Air Systems Team Public Affairs Office. (Contact Cathy Nodgaard at 703-604-2437 x6309)

N96-210 TITLE: Optical Beam Forming Network

OBJECTIVE: The large volume, weight, power and cooling systems have restricted the full performance of the radar aboard the Navy carrier based aircraft, such as the Airborne Early Warning (AEW) radar. Hence this objective is to replace the cumbersome radar devices with the Optical Beam Forming (OBF) network.

DESCRIPTION: The OBF network operating as an active array with solid state modules is to provide the true time delay. Its design with Photonic phase shifters is to allow for enhanced performance and reduce the cooling system, such as in the AEW radar. The true time delay and beam agility should provide for beneficial Direction Finding (DF) mission, and still utilize fewer DF antennas.

PHASE I: Conduct the OBF array system analysis and tradeoff analysis. Design the OBF active array with critical components necessary for development and demonstration.

PHASE II: Fabricate the airborne OBF active array prototype that will be used for field testing on the ground.

PHASE III: Develop the OBF system that is flight worthy for an initial Unmanned Aerial Vehicle (UAV), and followed by Navy/Marine carrier based aircraft demonstration.

COMMERCIAL POTENTIAL: It will provide for low-cost commercial systems required for the search, detection, and DF tracking of targets. The target could represent a surface vehicle, land or sea, with a survivor(s) who needs to be rescued.

REFERENCES: Mil-Std-1773

N96-211 TITLE: Ytterbium Yttrium Orth-Vanadate (Yb^{3+}:YVO_4) Laser Crystals

OBJECTIVE: Grow high optical quality ytterbium yttrium ortho-vanadate (Yb:YVO_4) crystals for use in 1 micrometer (μm) lasers.

DESCRIPTION: Neodymium (Nd^{3+}) YAG lasers are used in a wide range of both medical industrial and military applications. Navy applications of solid state Nd:YAG lasers include laser rangefinder, laser target designator, airborne target surveillance tracking and discrimination, EO/IR countermeasures, periscope detection, non-acoustic anti-submarine warfare (ASW) and mine detection. Diode pumped, Nd:YAG lasers are now available for use in military systems with improved efficiency and reliability at the expense of increased cost. Recently, researchers have demonstrated efficient laser operation with Yb:YAG lasers with an output at a wavelength of 1.03 μm versus 1.064 μm for the Nd:YAG laser. As compared to Nd:YAG laser, the ytterbium laser offers the following improvements (a) reduced thermal heating and optical distortion, (b) reduced number of laser diode pumps and hence lower costs and (c) less thermal control of laser diodes due to wide absorption bands. This effort will further improve the performance of the ytterbium laser by doping the Yb^{3+} ion into the YVO_4 host crystal.

PHASE I: Provide a feasibility demonstration of the growth of Yb:YVO_4 crystals of suitable optical quality and size for conducting spectroscopic studies and laser experiments. Crystal samples of a few millimeter size will be grown at Yb^{3+} dopant levels of 1, 3 and 5 atomic percent. Crystals will be cut and polished for spectroscopic analysis. Spectroscopic measurements will be conducted to determine the crystal absorption and fluorescence emission characteristics.

PHASE II: Grow, develop and test Yb:YVO_4 crystals of high optical quality and large size for use in commercial and military laser systems. Grow and deliver fabricated laser rods suitable for InGaAs diode laser pumping with loss of less than 0.1% per cm, size at least 3 by 30 mm and dopant level selected during the Phase I SBIR program.

PHASE III: Produce Yb:YVO_4 crystals for use in production military and commercial diode pumped, solid state laser systems.

COMMERCIAL POTENTIAL: Ytterbium laser operating at 1 micron output wavelength have commercial application in industrial machining, material processing, medical diagnostics and surgery. With nonlinear optic frequency conversion ytterbium lasers have application in x-ray lithography, remote sensing, optical data processing and storage and other photonics applications.

REFERENCES:
1. D. S. Sumida, CLEO 1995 Technical Digest, 174 (1995)
2. C. D. Marshall, etc., CLEO 1995 Technical Digest, 81 (1995)
3. L. DeShazer, Laser Focus World, February (1994)

N96-212 TITLE: Corrected Fiber Optic Laser Beam Delivery

OBJECTIVE: Develop a fiber optic laser beam delivery system with nearly diffraction limited beam quality.

DESCRIPTION: Large core, multimode optical fibers are used with high power lasers for beam delivery in medical and industrial applications. However, the output from these multimode fibers is highly divergent, distorted and depolarized. For

Navy airborne systems such as laser target designators (LTG), laser rangefinders (LRF), and electro-optic countermeasure (EOCM) jammers, it is desirable to have a high power laser beam delivery system with nearly diffraction limited beam quality. This effort will provide an innovative concept of a fiber optic laser beam delivery system for use with high power, short pulse width lasers for Navy applications.

PHASE I: Provide a feasibility study, which demonstrates the concept for a high quality fiber optic laser beam delivery system. Proof of principle experiments will be conducted with a nearly diffraction limited Q-switched Nd:YAG laser operated at 1.064 and 0.532 micrometer (μm) output wavelength. The goal is to transmit at least 70% of the input beam with nearly diffraction limited output beam quality over fiber optic lengths of 5 to 10 meters. For Phase I a fiber optic length of 1 meter is acceptable.

PHASE II: Develop and test a fiber optic laser beam delivery system, which provides the transmission of 1/2 to 1 joule "Q"-switched laser pulses over fiber optic lengths of 10 meters with nearly diffraction limited output beam quality.

PHASE III: Produce the fiber optic beam delivery system demonstrated in Phase II.

COMMERCIAL POTENTIAL: Laser beam delivery systems for high power lasers are used in medical and industrial processing applications.

REFERENCES:
1. G. J. Dunning and R. C. Lind, Opt. Lett. 7, 558 (1982)
2. S. C. Matthews and D. A. Rockwell, Opt. Lett. Vol. 19, No. 21, 1729 (1994)

N96-213 TITLE: Engineered Infrared Nonlinear Optical Materials

OBJECTIVE: To develop techniques to construct large nonlinear optical devices for doubling 9.2 and 10.6 micron radiation from a pulsed CO2 laser or use as an optical parametric oscillator (OPO) for converting 2 or 1 micron laser radiation to the 2-5 micron band. The Navy is interested in materials that can handle high average power input, ~100 watts with PRF in the multi Khz range.

DESCRIPTION: This research approach is directed to examine engineering of non-birefringent, nonlinear optical materials to construct a quasi-phased-matched structure. The materials used in bonding must be commercially available. Materials should be considered that double 9 to 11 microns to 4.5 to 5.5 microns
and can also be used as an OPO for generating the 2-5 micron band. Techniques for bonding layers of nonlinear material or growing of quasi-phase-matched (QPM) materials directly are acceptable. Other material can be used in the construction, however the overall device must work considering thermal effects and optical damage thresholds. The approach developed in phase I should lead to QPM nonlinear optical structures which are able to demonstrate efficiencies in excess of 30% by the end of phase II

PHASE I: The awardee should demonstrate the ability to construct IR nonlinear materials without a measurable interface loss.

PHASE II: The awardee must construct a nonlinear device with a 1 x 1 cm aperture, can reach at least 30% efficiency and greater than 30W output power. The vender may use a test system provided by the government (NAWC) to demonstrate the materials performance.

PHASE III: Produce QPM nonlinear optical structures for use in laser systems for industrial, medical and military applications.

COMMERCIAL POTENTIAL: QPM nonlinear optics can be used to frequency down-convert Nd:Yag lasers and frequency up-convert carbon dioxide lasers to the mid infrared spectral range. laser sources emitting in this spectral range have commercial applications which include wind shear detection, pollution
monitoring, remote gas leak detection and medical surgery.

REFERENCES:
1. "Analysis of a CdTe and CdMnTe quasi-Phasematched Optical Parametric Oscillator and Amplifier", William J. Scharpf B. P. Boczar, Optics Comm. 103 (1993) 429
2. "Diffusion Bonded Quasi-Phasematched GaAs", L. Gordan, G. L. Woods, R. Route, R.S. Feigelson, R. C. Eckardt, M. M. Fejer, R. L Byer, Conference on Laser and Electro Optics (CLEO), CPD10, (1993)

N96-214 TITLE: Image Matrix Merger

OBJECTIVE: To develop a FLIR image frame buffer/processor and required optics to allow multiple sequential images to be merged into a larger image.

DESCRIPTION: FLIR systems need a larger Field Of View (FOV) and increased resolution. This can be achieved by making the FLIR sensor array image a set of adjacent FOVs sequentially and then merge the result. The resulting combined image will have twice the horizontal & vertical FOV if four images are merged and no loss in resolution (or twice the resolution with no change in FOV). However an image processor is required to capture the images, then stretch & shift them to correct for aircraft movement so they all appear as if taken from the same aircraft location/orientation. The merged corrected image is displayed at 60 Hz though the composite update rate is low. The image processor must receive pitch, roll, yaw, altitude & velocity parameters from the aircraft and use it to compute shifting, rotating and stretching of the image at pixel rates. System distortion mapping and anti aliasing should also be included. Transport delay should be minimized.

PHASE I: Show feasibility which identifies fidelity impact, constraints, total system impact & efficiency. Include velocity, roll-pitch-yaw rates, slew rate, altitude above terrain, ratio of terrain/feature height vs altitude, number of images in a set, image overlap, update rate, display update rate, minimum visible slant range, etc. Specific beneficial situations should be identified (E.G. helicopter above 500 feet at 150 knots and roll less than 30 degrees per second may have 9 images in a set for triple resolution improvement). Develop required architecture, develop translation equations. Determine feasibility of algorithms, data rates, memory requirements etc.

PHASE II: Develop and build a prototype to test and operationally demonstrate the methods & system formulated in Phase I. The prototype shall demonstrate all software. The prototype may be a modification to a commercial FLIR.

PHASE III: Incorporate this new technology into new FLIR designs and modify current FLIRs with system upgrades.

COMMERCIAL POTENTIAL: Police surveillance.

REFERENCES: Riner, Bruce & Blair, Browder (1992) Design Guidelines for a Carrier-Based Training System. Proceedings of the 1992 IMAGE VI Conference (pp.65-73).

N96-215 TITLE: Innovative Methods for Minimization Glass Bead Abrasive Blasting Hazardous Waste Stream

OBJECTIVE: To develop processes and procedures which use innovative methods for the minimization of glass bead abrasive blasting, creating a hazardous waste stream. The method(s) shall be both economically and technically feasible.

DESCRIPTION: Currently, glass bead abrasive blasting, is one of the highest sources of hazardous waste at Naval Aviation Depots. Because of the way it is handled at some facilities, the cost of deposing of this blasting residue can be less than deposing of media as nonhazardous waste, so there is not an economic penalty for this waste. The NAVAIR 01-1A-509 Aircraft Weapons Systems Cleaning and Corrosion Control Manual contains procedures for glass bead abrasive blasting operation.

PHASE I: Identify and develop innovative method(s) to minimize the glass bead abrasive blasting hazardous waste stream that will meet current environmental laws/regulations. Conduct preliminary laboratory testing to demonstrate the feasibility of the method(s). Conduct an economic analysis of the alternatives.

PHASE II: Further develop the procedures to implement successful method(s) based on Phase I results. Conduct both laboratory testing and field testing. The method(s) shall be prototyped at one of Naval Aviation Depots. The processes and procedures shall be documented in a format that both industry and government facilities can use. The prototype set-up shall be a deliverable.

PHASE III: Once method(s) have been demonstrated and certified in Phase I and II efforts, the method(s) shall be made available for Navy, government, commercial, and/or other use.

COMMERCIAL POTENTIAL: Methodology shall be transferable to commercial aircraft maintenance and overhaul sites utilizing glass bead abrasive blasting. Any minimization techniques identified during this research project will also be applicable to any industries using glass bead abrasive blasting.

REFERENCES:
1. MIL-G-9954
2. Technical Manual NAVAIR 01-1A-509 pages 5-1, -10, -11, -12, and -13. (Contact Cathy Nodgaard at 703-604-2437 x6309)

N96-216 TITLE: Single Component Sealant for Watertight Integrity and Corrosion Control

OBJECTIVE: To develop a single component fast curing sealant.

DESCRIPTION: Access panels are routinely and hurriedly removed and replaced during aircraft maintenance while aircraft are parked on aircraft carrier flight decks in-between at sea flight operations. Fasteners are currently sealed with two-component epoxy sealant which in most cases is not cured completely before aircraft are flown. The resultant air flow during flight pushes the soft epoxy sealant away from the fasteners, and corrosion protection is removed. A fast drying single component sealant is needed for corrosion protection that provides adequate sealing and allows easy fastener removal. The NAVAIR 01-1A-509 Corrosion Manual contains approved aircraft sealant applications as well as individual aircraft maintenance instruction manuals (MIMs).

PHASE I: Adapt or develop a single component fast drying sealant for aircraft use with the following characteristics: a 350 degree F. capability (not mandatory), meet all environmental regulations, paint will adhere to, be flexible/malleable, be in liquid form and ambient temperature storage (not mandatory). At the end of Phase I, the contractor will forward a sample of the single component sealant system to the Naval Air Warfare Center, Aircraft Division, Patuxent River, MD for evaluation.

PHASE II: Further develop the new single component sealant system developed under Phase I. Conduct both laboratory testing and field testing. The testing shall demonstrate that the new single component sealant meets all the performance requirements and environmental laws/regulations for target application(s). If necessary, propose amendments to existing military specification or propose new military specifications for this single component sealant.

PHASE III: Produce the single component sealant system demonstrated in the Phase II effort for both the military and commercial market.

COMMERCIAL POTENTIAL: The new single component sealant can be used on commercial aircraft as well as non aerospace applications for both the government and private sector. Therefore, this technology is directly transferable.

REFERENCES: MIL-S-81733, MIL-S-83430, MIL-S-29574 and MIL-F-7179

N96-217 TITLE: Optical Time Domain Reflectometer Development

OBJECTIVE: To develop a time domain reflectometer that is compatible with 100/140/172 micron fiber optic cable.

DESCRIPTION: The Aerospace Industry has developed a 100/140/172 micron fiber optic cable for high speed data transmissions between avionic systems. Connector and splice technologies have followed the cable development, establishing a complete fiber optic interconnect system that is repairable. It is necessary to perform simulated function checks of this system during installation and maintenance. Time domain reflectometry offers excellent diagnostics of the interconnect system when performing the simulated functional analysis. The Aerospace Industry has identified the required functions for an optical time domain reflectometer (OTDR), and they are as follows:

a) No dead zones
b) Functional for short distances
c) User friendly control panel
d) Peculiar system mapping capability
e) Packaged for military maintenance environment
f) Compatible with light transmission characteristics of the subject fiber optic cable
g) Acquisition costs consistent with typical flight line analytical equipment

Currently, commercial OTDRs are available, but fall short of meeting the criterion mentioned above.

PHASE I: The contractor must provide a feasibility study which develops/demonstrates the capabilities of an OTDR design that meet the described characteristics.

PHASE II: The contractor must develop and deliver a functional prototype unit for field analysis and develop and deliver a draft operational manual that instructs the user in the proper function of the OTDR. The customer will identify the final product as the diagnostic tool to locate discrepancies in the fiber optic interconnect system.

PHASE III: Production and deployment to the maintenance community.

COMMERCIAL POTENTIAL: The proposed equipment will be capable of supporting commercial aviation in the installation

and maintenance of the fiber optic interconnect systems on commercial aircraft. The Boeing Company is currently utilizing fiber optic interconnect systems on the 757, 767, and new 777 airframes. The configuration of the fiber optic interconnect system utilized by Boeing is similar to the militarized system used by the F-22, RAH-66 and F/A-18 E/F aircraft. The OTDR described here will be capable of performing the same system diagnostics on commercial and military aircraft.

N96-218 TITLE: Fiber Optic Microwave Transmission System

OBJECTIVE: Use fiber optics to transfer microwave signals.

DESCRIPTION: Aircraft fuselage shielding to the external electromagnetic environment is critical to their safe operation. The shielding is measured from an instrumentation system which is kept outside the aircraft and probes that are placed inside the aircraft. An investigation of fiber optics as a means to transfer the signals from the probes to the measurement system is required. Current test methods only allow the use of coaxial cables at high microwave frequencies. The cables pick up leakage from the external environment and require holes and bulkhead connectors to be put in the fuselage. Fiber optics do not pick up leakage and can be routed through existing pipes and apertures. Current fiber optic equipment permit signals up to 1 GHz to be transferred. Several developments in fiber optics make it possible to consider that microwave signals from 1 Ghz to 18 Ghz can be transferred while maintaining original signal characteristics (amplitude, phase and modulation) with comparable or better than coaxial cable performance.

PHASE I: Determine the feasibility of using a Fiber Optic Microwave Transmission System to transfer 1 to 18 Ghz signals with better than coaxial cable performance.

PHASE II: Develop and demonstrate the proposed Fiber Optic Microwave Transmission System. The demonstration will involve both characterization of the system and trial application in an aircraft to determine ability to support measurements of internal electric fields.

Phase III Produce Fiber Optic Microwave Transmission Systems for use in weapon system research, development, engineering, test and manufacturing. This will be transition into military and commercial aircraft programs.

COMMERCIAL POTENTIAL: Modern civil aircraft are incorporating fly-by-wire (FBW) and full authority digital engine controls (FADEC). The FAA has established regulations for safety operation of these systems when exposed to high intensity radiated fields (HIRF) seen in civil airways and airports. The industry has recommend the measurement of the aircraft shielding as one requirement to obtaining data necessary to certify civil aircraft safe for operation in HIRF. These Fiber Optic Microwave Transmission Systems would be used to obtain the required data.

REFERENCE: MIL-HBK-235

N96-219 TITLE: High Frequency Lossy Line Extension

OBJECTIVE: Extend RF attenuation of Lossy Line down to the HF range.

DESCRIPTION: Aircraft currently use Lossy Line to attenuate unwanted Electromagnetic Interference (EMI) signals from UHF and higher frequencies. Basic research data indicates that Lossy Line could be extended to provide similar attenuation all the way down to the HF range. The HF range is the area where air capable ships produce one of the harshest electromagnetic environments. The currently used heavy overbraided cables are terminated with EMI backshell connectors which impede maintenance. The proposed HF Lossy Line would eliminate the need for the overbraided cables and EMI backshell connectors, thereby decreasing weight and improving maintainability.

PHASE I: Provide a feasibility study which develops methods to increase RF attenuation of lossy line down to the HF range. The study should include consideration to maintain exiting common cable performance aspects. (i.e. corrosion resistance, bend radius, interchangeably with exiting wire types, etc.)

PHASE II: Develop and demonstrate production representative quantities of HF Lossy Line. The test may involve both characterization of the HF Lossy Line and installation in an aircraft to determine system level performance.

Phase III Produce HF Lossy Line for use in weapon system engineering and manufacturing development. This will be the transition into military and commercial aircraft programs.

COMMERCIAL POTENTIAL: Modern civil aircraft are incorporating fly-by-wire (FBW) and full authority digital engine controls (FADEC). The FAA has established regulations for safety operation of these systems when exposed to high intensity

radiated fields (HIRF) seen in civil airways and airports. The civil aircraft industry will want to use HF lossy line to attenuates the HIRF protecting their FBW and FADEC systems. In addition electronic systems in cars, truck and other vehicles could benefit from HF Lossy Line.

REFERENCES:

1. MIL-HBK-235
2. FAR-xx.1317
3. MIL-STD-C-85485

N96-220 TITLE: Faster High Intensity Radiated Fields (HIRF) Testing from 10 Khz to 40 Ghz

OBJECTIVE: A technique for high-power Electromagnetic Environmental Effects (E3) testing of aircraft systems and subsystems to reduce test time by a factor of two or more.

DESCRIPTION: The Navy currently uses a series of high power RF sources and antennas for HIRF testing of aircraft systems over the frequency range of 10 Khz to 40 Ghz. The capability is not continuous over the 200 MHZ to 40 Ghz range where 11 spot frequencies are used. The test techniques require repositioning of antennas or test objects to achieve HIRF environments on specific systems. The tests are time consuming which tie up aircraft systems as well as test facilities. This effort will provide for HIRF testing using lower power sources over broader frequency ranges while providing acceptable HIRF environments and for more complete illumination of the test objects in order to reduce test time involved with repositioning test equipment or test objects.

PHASE I: Provide a feasibility study which identifies a simulation approach and technique to halve the time required for HIRF testing. The method must be compatible with aircraft systems and subsystems testing using existing instrumentation techniques, and capable of meeting HIRF requirements to provide an RF environment over the frequency range of 10 Khz to 40 Ghz at average power levels of 200 V/m and peak power of 30,000 V/m. The proposed method must be capable of being tested and demonstrated inside the Shielded Hangar, Building #144 at NAWCAD, Patuxent River, MD.

PHASE II: Develop a prototype and demonstrate the approach and technique formulated under the Phase I SBIR effort.

PHASE III: Produce the HIRF test capability prototyped and demonstrated in the Phase II effort. This will provide a self-contained HIRF test facility for the military's E3 capability to test aircraft and aircraft related systems including tactical, recognizance, and strategic aircraft.

COMMERCIAL POTENTIAL: New capability can be used to qualify systems to the new FAA requirements to harden commercial aircraft against HIRF and for providing the coupling data to certify aircraft. This issue is critical to new generations of fly-by-wire and fly-by-light aircraft systems.

REFERENCES:

1. MIL-STD-1818
2. Part 6, Section G of DoD Instruction 5000.2

N96-221 TITLE: Electronic Maintenance of Equipment Identification and Configuration Data

OBJECTIVE: To increase the validity and efficiency of equipment identification and configuration data used to manage and control assets by eliminating the manual procedures now in use.

DESCRIPTION: The Navy currently uses a manufacturer's identification plate to display equipment identification data. Equipment configuration data is either stenciled on the side of the equipment or hand written on a sticker that is attached to the equipment. In either case the printed data must be converted from printed to electronic data before it can be used in a computerized data base. The manual conversion of printed data from identification plate, stencil or sticker to electronic data provides the opportunity for human induced errors. Data is often misinterpreted or data elements are transposed during conversion. Damage to identification plates, stencils or stickers can also result in inaccurate data interpolation.

With an ever-shrinking budget the requirement for a more aggressive management system for military assets is imperative. A system that allows electronic collection of equipment identification and configuration data is essential. The accuracy of the input to the computer environment that exists in the military today is critical to equipment identification, tracking

and configuration systems. Accuracy of the input to the management data bases of the future will become more critical as the Department Of Defense consolidates the equipment purchased by the different branches of the armed services.

PHASE I: Provide a feasibility study which develops a method(s) to place the equipment identification and configuration data on the equipment in a form that can be retrieved electronically. The method should maintain an open architecture, have input compatibility with standard data collection data bases, have minimal impact on equipment form, fit and function and be cognizant of weight and balance restrictions. Equipment operational environment determination is critical since most military equipment is exposed to a harsh environment (i.e. temperature & pressure extremes, dirt & chemicals, etc.).

PHASE II: Develop, test, evaluate and operationally demonstrate the method(s) developed during Phase I.

PHASE III: Provide the government with the system to implement the method(s) developed in Phase II. This will be the transition into the military's equipment identification and configuration tracking systems.

COMMERCIAL POTENTIAL: The methods developed will have an open architecture and can be used by all military and commercial activities. All users will be able to use this method to identify equipment and allow electronic collection of identification and tracking/configuration data.

REFERENCES:
1. MIL-STD-130
2. MIL-STD-129
NOTE: These are general references and should not restrict the feasibility study. We are looking for new technologies and they should be explored.

N96-222 TITLE: Advance Model-Based Reasoning

OBJECTIVE: Develop tools to provide software models of Units Under Test (UUT) for developing Test Program Sets (TPS). To use these models in creating test software utilizing inferred reasoning concepts.

DESCRIPTION: Diagnostic test development for UUTs is the largest cost element involved in creating a Test Program Set (TPS). Diagnostic test procedures must be tested by manually inserting faults on a UUT. Typically only a small fraction of possible faults are actually inserted and verified. A new software tool that can simulate a UUT's diagnostic logic will save the expense of lengthy diagnostic software troubleshooting. The new tool should employ improved diagnostic algorithms to shorten the development time and improve fault diagnostic performance. The new tool should also include a run-time component to provide automated diagnostic capability in run-time.

PHASE I: Define a Re-Engineering TPS Development Process using advanced reasoning technology. Define an implementation strategy for use of the technology across TPS development programs.

PHASE II: Based on successful completion of Phase I, develop and test a sample item and conduct a proof-of-concept demonstration.

PHASE III: Produce the software tools which can be used by the test industry.

COMMERCIAL POTENTIAL: Industries developing Test Programs will benefit from the use of these new tools through reduced engineering costs.

N96-223 TITLE: Improved Visual Landing Aids on Air Capable Ships

OBJECTIVE: To improve and modernize the Visual Landing Aids Systems on Aviation Capable Ships by developing and integrating emerging technologies into a synergistic approach to replace current standalone and obsolete components.

DESCRIPTION: Visual Landing Aids (VLA) provides a means for day and night aircraft operations from Aviation Capable Ships. The suite of equipment provides visual cues for accomplishing safe aircraft operations under various mission requirements. This is made possible by providing the approaching aircraft pilot with a well defined glide path and line-up information along with enhanced flight deck illumination, depth perception cues, and obstruction definition. Components of the VLA suite include, but are not limited to, the following: Glide Slope Indicator, Line-Up Lights, Horizon REFERENCE Set, Waveoff Lights, Flight Deck Status and Signaling System, Floodlights, Deck Edge Lights, Rotary Beacons, Lighting Controls, etc. While selected VLAs on Navy aircraft carriers and large deck amphibious assault ships have undergone recent improvements, the VLA suite on Aviation Capable Ships has remained relatively unchanged for the last 25 years. The existing

systems are old, obsolete, large, heavy, maintenance intensive and incompatible with other systems such as night vision devices. There is a need to examine the existing VLA suite and transition promising technologies into fieldable systems for the current and next generation of Aviation Capable Ships thus increasing their affordability.

PHASE I: Examine the current generation of Aviation Capable Ships VLA and develop concepts for integrating advanced technologies into their VLA suite. Aviation operations involving night vision devices shall also be included in this study. A top level performance model, based on a single aviation ship platform, shall also be provided.

PHASE II: Develop a detailed performance model(s) for VLAs on a specific current class of Aviation Capable Ship. This model shall interface with the Navy's Manned Flight Simulator. The contractor shall further develop a particular VLA concept using the model and install it in the Manned Flight Simulator and demonstrate/evaluate its capability.

PHASE III: The contractor shall take the approved and verified VLA concept(s) and implement the concept(s) into hardware and software. The new VLA will then be installed on a ship for demonstration and evaluation at sea.

COMMERCIAL POTENTIAL: This technology has application in commercial and private airports as well as off-shore drilling platforms and seabased aviation for the commercial shipping industry or US Coast Guard.

N96-224 TITLE: Piloted Approach Decision Aid Logic (PADAL) System

OBJECTIVE: To develop a Piloted Approach Decision Aid Logic (PADAL) system which would identify and monitor potential unsafe operating conditions and trends that would necessitate a waveoff to preclude a ramp strike or other catastrophic landing mishaps while at the same time increasing aircraft boarding rates.

DESCRIPTION: The Landing Signal Officer (LSO) is responsible for the safe and expeditious recovery of all Naval aircraft aboard ship. LSOs, of various types, are deployed with all aviation capable ships. The LSO has many sources of information and data as well as his/her own instincts and training available to enable him/her to fulfill these important responsibilities. Strict application of the 'safe recovery' principle encourages the production of very conservative waving strategies and reduced boarding rates. Expeditious recovery of aircraft as a single waving principle could produce a greater incidence of shipboard landing mishaps. Each LSO is challenged to develop their own waving strategy, including a set of waveoff criteria, that allows safety to override expediency in aircraft recovery. However there are many variables which influence the LSO's definition of their waving window. They include: aircraft, ship, environmental, pilot and LSO factors. Certainly, the integration of these models presents a difficult problem. A decision aid system which will allow the LSO to more easily evaluate the approaching aircraft and if necessary, initiate a timely waveoff, is required. Recent developments in the area of knowledge based systems offer the opportunity to provide a means of aiding the LSO in ensuring the safe and expeditious recovery of aircraft.

PHASE I: Determine the feasibility of developing a system that would identify and monitor unsafe aircraft recovery trends and provide information to flight safety personnel. Include the identification of: waveoff criteria, waveoff related variables, aircraft performance models, applicable ship performance models, pilot performance models and LSO performance models. The contractor shall provide the detailed architecture of the decision aid model.

PHASE II: Develop a detailed performance model for the decision aid system. Develop a breadboard system, including hardware and software, which will interface with the Navy's LSO Training Simulator. Install the system into the Training Simulator and demonstrate/evaluate it's capability.

PHASE III: A transition to an advanced development effort by the contractor will provide a full capability system which would be installed on an aircraft carrier for demonstration and evaluation at sea.

COMMERCIAL POTENTIAL: This technology has application in the private and public sector particularly in commercial air traffic control or in any other area where critical decisions based on a set of highly dynamic information must be made.

N96-225 TITLE: Hydrogen Fuel Cell for Powering Aviation Support Equipment.

OBJECTIVE: The objective of this topic is to develop an efficient low emitting (both in noise and pollution) form of power for aviation support equipment.

DESCRIPTION: The present support equipment found on naval and marine ships are either powered using diesel type fuels or batteries. Both have short comings do to noisy engines, pollution emissions, toxic gasses during charging, explosive and corrosive conditions, high voltage dangers for personnel, among others. In addition, batteries require recharging often which increases the number of required support equipment. A more efficient power source could potentially increase productivity,

decrease fuel consumption and reduce pollution emissions. One possible power source is what is known to be, "Fuel Cell."

PHASE I: Investigate all possible fuel cell forms that could be used in military applications, and develop a study report. The study will compare fuel forms, power efficiencies and densities, emissions, cost, and maintainability. The study will also compare the fuel cell with conventional forms of power and advanced battery concepts. At the conclusion of the report will define a preliminary conceptual design is required to fit the fuel cell to a piece of support equipment that will be selected by navy personnel.

PHASE II: Fully design and develop the fuel cell conceptually designed in phase I. Fit into the support equipment (i.e. spotting dolly) and demonstrate capacity.

PHASE III: Finalize design of the fuel cell and develop transition package for future support equipment.

COMMERCIAL POTENTIAL: The largest commercial application for this technology is transportation and electric power. There are presently a few experiments underway which have been funded by DOE, Canada, General Motor, Allison Gas Turbine Division, and Mazda to name a few using fuel cells to power busses. This is attacking the larger more expensive commuter market. If successful the fuel cell developed in this program will be capable of powering small cars and trucks.

REFERENCES: Proceedings from short course: "Batteries and Fuel Cells." UCLA, Engineering 869.2, E9413, April 27-29, 1994

N96-226 TITLE: Fuel Bladder Cell Failure Identification

OBJECTIVE: To develop a system to identify activation of the self-sealing material in self-sealing fuel bladder cells.

DESCRIPTION: The purpose of self-sealing fuel cells is to prevent loss of fuel from ballistic impacts. These cells consist of a multi-layer elastomeric construction, made from the inside out, of a fuel resistant inner ply, a fuel vapor barrier layer, alternate layers of fuel sensitive elastomer sealant (the self-sealing layer), and plies of elastomer coated fabric plus a fuel resistant outer coating. When fuel or fuel vapors come in contact with the self-sealing material, the material swells to seal the hole and stop fuel leakage. There are three basic failure mechanisms that cause activation: the cell is punctured, either by ballistic impact or obvious maintenance induced damage; the fuel vapor barrier is broken, either by natural wear and tear or by non-obvious maintenance induced damage; or by fuel exposure of the outer layer of the fuel cell. Once the material is activated the cell must be removed from the aircraft and repaired or disposed of. If a cell with a small area of activation remains in the aircraft for a extended period of time, the entire self-sealing layer will activate. A fully activated cell does not provide ballistic protection, will eventually leak and may fail catastrophically. Unfortunately, there is usually no immediate indication of activation while the cell is installed in the aircraft. Given time, fuel will start leaking out of the aircraft cavity drains. Navy Depot personnel estimate approximately 10 to 40% of the self-sealing fuel cell in the Navy's fleet are currently activated. With current technology the only way to detect activation is to inspect the inside of the fuel cell. On most aircraft, gaining access to the inside of the fuel cell is a costly and time consuming maintenance action. The benefits of this effort will include reduced aircraft down time, improved reliability/maintainability and reduced replacement costs.

PHASE I: The primary activities during Phase I will be to identify a potential technology and/or system to detect fuel cell activation without requiring maintenance personnel to enter the fuel cell. Also identify a technology to detect/isolate fuel leaks originating from the fittings or bladder wall. The system may be passive or active. The system should be lightweight, reliable, and utilize commercially available material. The system should not decrease the reliability of the fuel cell. The contractor will be required to perform lab test to show the potential for the technology and/or system to detect activation.

PHASE II: During Phase II the contractor will be required to demonstrate the technology and/or system on self-sealing test cubes. The performance, effectiveness, sensitivity, weight, reliability and maintainability of the technology will be evaluated and quantified. The contractor must separately evaluate the system when activation is caused by a failure of the vapor barrier and fuel exposure of a damaged outer liner.

PHASE III: During Phase III, the contractor will propose his design concept in a new aircraft system to be implemented.

COMMERCIAL POTENTIAL: This system could be utilized in aircraft that use self-sealing fuel bladder cells.

REFERENCES: MIL-T-5578, MIL-T-6396 and NAVAIR 01-1A-35 (Contact Cathy Nodgaard at 703-604-2437 x6309)

N96-227 TITLE: Determine the State of State of Stress in Non-Ferromagnetic Metals and Composite Structures.

OBJECTIVE: Develop a portable user friendly nondestructive inspection method (hardware/software) capable of performing residual stress measurements in non-ferromagnetic metals and nonmetallic composite materials.

DESCRIPTION: As the Navy's aircraft and engines age, the need exists to determine residual stresses in structures manufactured from non-ferromagnetic materials (hastelloy, inconel, stainless steels, titanium, and aluminum alloys) and nonmetallic composite materials. These residual stresses could be imparted to these structures by in-service operation, manufacturing, assembly, or rework.

PHASE I: Identify a new, or modify an existing NDT method capable of detecting and measuring the state of stress in non-ferromagnetic metals and nonmetallic composite materials. Develop a test plan and conduct preliminary laboratory testing to determine the feasibility of the potential NDT method, to correlate the state of stress to remaining fatigue life and document on final report for evaluation.

PHASE II: Develop the selected NDI method, and design a prototype portable inspection system. Test the prototype system as determined by the Phase I feasibility study. Produce and deliver the prototype system.

PHASE III: Develop equipment specifications upon successful completion of Phase II for military and industrial applications.

COMMERCIAL POTENTIAL: The developed NDI method and inspection system will provide the aerospace, automotive, marine, and construction industry the ability to not only produce a better product, but to have the ability for true life cycle monitoring of their products.

REFERENCES: NAVAIR O1-1A-16 (Contact Cathy Nodgaard at 703-604-2437 x6309)

N96-228 TITLE: Comprehensive Electrical Evaluation of Polyalphaolefin Dielectric Coolant

OBJECTIVE: To develop a test method (hardware/software) for evaluation of the electrical properties of polyalphaolefin dielectric coolant and determine whether a different routine method should be developed to verify the fluid's ability to withstand an electrical stress.

DESCRIPTION: The Navy has converted several of its aircraft weapon systems and ground support equipment to a polyalphaolefin dielectric coolant. Routine testing indicates a lowering of the fluid dielectric breakdown strength. This test is utilized to determine how the fluid responds to an electrical stress. Limits were set based on aircraft requirements. Cumulative data suggests an increase in the fluid's failure rate; however, a correlation with hardware failures has not been demonstrated. Limited studies indicate that a different test method/methods is required and electrical properties testing necessary.

PHASE I: Provide a feasibility study which develops a different method to test the electrical properties of polyalphaolefin dielectric coolant. Feasibility should also include any trade-off noted in the OBJECTIVE of this topic.

PHASE II: Develop, test and demonstrate the test method(s) formulated under Phase I SBIR efforts. Demonstrate correlation with associated hardware.

Phase III: Prototype necessary test equipment and transition into the Navy's Liquid Coolant Program.

COMMERCIAL POTENTIAL: Polyalphaolefins are utilized in many commercial applications. Verification of the stability of the fluids and their ability to withstand high voltage will be beneficial to commercial uses.

REFERENCES: MIL-C-87252 and ASTM D877

N96-229 TITLE: Open Systems to Legacy Systems Communications Bridge

OBJECTIVE: Identify and develop a hardware and software interface technology permitting legacy Navy systems (with their military-unique interfaces) to be "plug-and-play" with COTS systems supporting Open System interface standards.

DESCRIPTION: One of the most difficult problems faced when upgrading existing Navy systems is their use of military unique I/O interfaces (e.g. MIL-STD-1553, NTDS, PDC, etc.) The emphasis on new acquisitions is to use Commercial-Off-The-Shelf (COTS) hardware and software. However, COTS hardware rarely supports the required military interfaces, opting rather for

open systems interfaces such as: FDDI/Safenet, Scaleable Coherent Interface (SCI), High Speed Data Transfer Network, SCSI, and IEEE Parallel Bus. This requires system integrators to develop elaborate work-arounds to connect the new sub-system with the existing system. These work-arounds are difficult to maintain as the COTS components are continually upgraded.

If an adaptable, configurable communications bridge existed which could link the military-specific interfaces to open systems interfaces, new sub-systems could be more easily developed and integrated that would be less impacted by changes to other parts of the weapons system. This would also facilitate easier upgrades to the new COTS system components.

Although in most cases, the upgrade path involves replacing all military-unique components with COTS components, there will always be some cases where an existing military sub-system is so well tested and proven that there is no desire to replace it, or where there is no equivalent commercial product. Also, due to limited funds available for upgrades, it is likely that most major system upgrades will be done incrementally. The communications bridge will be an invaluable, re-usable tool to facilitate both of these scenarios.

It should be noted that the communications bridge can link systems with I/O devices or systems with other sub-systems. The bridge can link commercial interfaces with military interfaces or even link multiple commercial interfaces. It may be easier to conceptualize the communications bridge as a data router on a Wide Area Network (WAN). The router, among other things, handles conversions between multiple protocols as well as determining packet destinations and the most efficient data path.

PHASE I: Investigate and identify both the military-unique as well as open systems communications protocols and interfaces. Select those interfaces most likely to be required in upcoming major weapon systems upgrades. Design a multi-protocol data communications bridge that is configurable, extensible, and adaptable to new commercial interface standards.

PHASE II: Develop a software simulation of the communications bridge and determine the design and underlying hardware required for acceptable data throughput under different loading conditions. Incorporate the concept of differing data packet priorities.

PHASE III: Build a communications bridge that supports a minimum of: FDDI, 1553, NTDS-B, HSC, PDC, and SCSI interfaces and integrate it with the AN/UYS-2A(V) hardware and software development facility.

COMMERCIAL POTENTIAL: By extending this concept slightly, it would be possible to develop an adaptable high-capacity communications bridge that would allow companies to upgrade their legacy systems that rely on obsolete commercial interfaces as well as develop new systems that use the data bridge to isolate the system from multiple I/O interfaces. For example, an SCI could connect the system to the communications bridge. The communications bridge could then disseminate the information to other sub-systems via a combination of FDDI, SCSI, and serial channels.

N96-230 TITLE: Design Assistant for Application of System Identification and Adaptive Control to Aircraft Flight Systems

OBJECTIVE: Develop system identification algorithms and software for complete nonlinear analysis of aircraft high angle of attack dynamics.

DESCRIPTION: The demands for increasing performance from defense and commercial systems combined with the phenomenal jump in the computational speeds of computers have opened up a number of opportunities for the application of System Identification (SI) and Adaptive Control (AC) technologies. However, rapid progress in this area is hindered by a lack of design guidelines and user-oriented software tools to assist, guide and train the end user in the proper application of these technologies. Recent advances in Expert System and Computer Based Training (CBT) technologies make it feasible to develop Design Assistants (DA) and CBT packages for applications of SI and AC to control problems in aerospace and other industries.

Phase I of the SBIR effort will (I) perform state-of-the-art survey of on-line and off-line SI techniques for linear and nonlinear dynamic systems (ii) select a set of design challenge problems related to aircraft flight testing, self-repairing flight control and on-board system diagnostics (iii) develop design guidelines and (iv) perform top level conceptual design of DA and CBT packages.

Phase II will involve software product development, testing and validation, delivery and commercialization planning for both SI and AC packages.

PHASE III: Will provide for the production, delivery and commercialization planning for both SI and AC packages..

COMMERCIAL POTENTIAL: System Identification and Adaptive Control technologies are being applied across a wide spectrum of applications including power, aerospace, manufacturing, communication, transportation and process control. The products of this SBIR project will benefit designers of control and signal processing systems in these industries.

RFERENCES: MIL-STD-8785C, MIL-STD-9490

N96-231 TITLE: Image Generator Frame to Frame Update Post Processor

OBJECTIVE: To develop an Image Generator(IG) post processor which computes updated images exploiting frame to frame coherence in the 2-D and pseudo 3-D domain.

DESCRIPTION: A tradeoff exists between the image quality and update rate of an IG for training simulators. As the IG is allocated more time to compute a higher quality image, the update rate decreases causing increased transport delay and stepping. Current post processing technology is limited to horizontal and vertical shifting of the image as discussed in the REFERENCE and takes only limited advantage of possible savings. An effective IG post processor could increase system performance by 1.5 to 5 times by allowing the IG to run at a lower update rate. The post processor stores a high resolution over sized image from the IG and outputs a high resolution image at video display rates. It should receive pitch, roll, yaw, elevation & velocity information at the video display rate and use it to compute shifting, rotating and stretching of the image at pixel rates. A non-moving image should be overlaid after shifting. System distortion correction, brightness correction and anti aliasing should also be included. Transport delay should be minimized.

PHASE I: Provide feasibility study which identifies fidelity impact, constraints, total system impact & efficiency. Include velocity, roll-pitch-yaw rates, altitude above terrain, ratio of terrain/feature height vs altitude, IG update rate, display update rate, minimum visible slant range, etc. Specific categories of feasible post processor applications should be identified (E.G. fixed wing aircraft above 1000 feet, less than 900 knots and roll less than 180 degrees per second may be updated at 15 Hz IG rate). Develop required architecture, develop translation equations. Determine feasibility of algorithms, data rates, memory requirements etc. Possibly include a non-real-time demonstration.

PHASE II: Develop and build a prototype to test and operationally demonstrate the methods & system formulated in Phase I. The prototype shall demonstrate all software and be driven with a real time training simulator IG and database.

PHASE III: Incorporate this new COTS into new training simulators and visual system upgrades.

COMMERCIAL POTENTIAL: Commercial flight simulators.

REFERENCES: Riner, Bruce & Blair, Browder (1992) Design Guidelines for a Carrier-Based Training System. Proceedings of the 1992 IMAGE VI Conference (pp.65-73).

N96-232 TITLE: Enhanced/Operator Machine Interface

OBJECTIVE: The objective of this topic is to demonstrate the feasibility of providing a method for improving system performance by enhancing the operator machine interface taking into account the diverse and changing skill levels of avionics sensor operators.

DESCRIPTION: The Air avionics sensor operator (SENSO) requirements pose a major challenge in complexity, quantity of data and real time constraints. The increasing importance of littoral warfare with potentially dense contact and dynamic threat environments further exacerbates these problems. SENSO's with varying experience and skill levels must make real time decisions involving system configuration and contact detection and evaluation for multiple sensor systems. The lack of real missions often results ins reduced skill in areas not practiced. Providing an ability to diagnose the skill level and provide appropriate OMI enhancements will significantly benefit the mission. In order to achieve the desired performance gains the skill level of individual operators must be accurately assessed and upgraded so that compatibility with the OMI is maintained before and during system deployment. The proposed techniques should provide the ability to diagnose and improve operator skill levels and utilize the improving skill levels to enhance the OMI for improved system performance.

PHASE I: Provide a proof of concept through a limited demonstration of OMI performance improvements for a selected subset of generic operator tasks related to the LAMPS SH-60R Multi-Mission Helicopter Upgrade (MMHU) SENSO's OMI. A plan will be provided that extends the Phase I concepts to the operator tasks associated with a selected sensor system's operational modes.

PHASE II: Generate software hosted on COTS hardware for diagnostic skill level evaluation and enhanced OMI for a selected SENSO mode. A demonstration with Phase II software/hardware with selected operators will quantify system performance improvements.

PHASE III: Develop diagnostic skill level and OMI enhancement packages for remaining SENSO modes of the LAMPS SH-60R MMHU sensor suite. Integrate the software packages into the host system.

COMMERCIAL POTENTIAL: This technology has dual use applicability to all commercial and businesses computer based

systems who's performance depends on real time operator skill levels. These applications include, Air Traffic Control, Production Line Control, Emergency Service Dispatching. Stock Trading and many different kinds of computerized learning software.

REFERENCES:
1. Williams, K.E. (1993a). Knowledge acquisition: A review of manual, machine aided and machine learning methodologies. Office of Naval Research Technical Report Contract N00014-91-J5-1500.
2. Williams, K.E. (1993b) The development of an automated cognitive task analysis and modeling process for intelligent tutoring system development. Technical Report: Contract No. N00014-91-J-5-1500. Office of Naval Research, Cognitive Sciences Program, Arlington, VA.

N96-233 TITLE: Trade-Off Techniques for Training Using Multimedia

OBJECTIVE: Develop trade-off techniques to determine the most effective combination of media to maximize learning.

DESCRIPTION: Multimedia technology is advancing rapidly and is prevalent in the marketplace. For training, multimedia provides the ability to generate captivating graphics, and relatively inexpensive animations and simulations. The exciting presentation of materials directly involves the learner in the instructional experience and is highly motivating. Multimedia is clearly a valuable tool for learning. The challenge is in determining how to best use multimedia to promote learning.

PHASE I: Develop trade-off analysis techniques based on a combination of analysis of existing applications and experimentation.

PHASE II: Develop a prototype multimedia system using trade-off analysis techniques and validate the effectiveness of the prototype and the trade-off tool.

PHASE III: The trade-off analysis can be marketed to commercial developers and consumers of multimedia training. In the military, the trade-off analysis will be integrated into the media selection model.

COMMERCIAL POTENTIAL: Multimedia is being used in commercial training and a trade-off analysis would be useful.

REFERENCES:
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2. Developing Multimedia for Technology Education. Stier, Kenneth. Technology Teacher, v54 n1 p17-20 Sep 1994.
3. Evaluating Interactive Multimedia. Reeves Thomas C. "Educational Technology", v32 n5 p47-53 May 1992.
4. Factors to Consider in Evaluating Multimedia Platforms for Widespread Curricular Adoption. Knight, Pam. "Educational Technology," v32 n5 p25-27 May 1992.
5. Fifteen Principals for Designing More Effective Instructional Hypermedia/Multimedia Products. Cates, Ward Mitchell. Educational Technology, v32 n12 p5-11 Dec 1992.
6. Interactive Multimedia Research Questions: Results from the Delphi Study. Ferretti, Ralph P. Journal of Special Education Technology, v12 n2 p107-17 Fall 1993.
7. Learning with Media. Kozma, Robert B. "Review of Educational Research" v61 n2 p179-211, 1991.
8. Military Standard 1379D.
9. Multimedia Sandbox: Teaching, Learning, and the Transfer of Knowledge. D'Ignazio, Fred Computing Teacher, v20 n2 p54-55 Oct 1992.
10. Planning for Multimedia. Trotter, Andrew. Executive Educator. v15 n6 p18-21 Jun 1993.
11. "Reinvesting Schools: The Technology Is Now" National Academy of Science and National Academy of Engineering convocation, May 10-12, 1993.
12. Ten Commandments for the Evaluation of Interactive Multimedia in Higher Education. Reeves, Thomas C. Journal of Computing in Higher Education, v2 n2 p84-113 Spr 1991.
13. Towards the Architecture of an Instructional Multimedia Database. Verhagen, Plin W., Bestebreurtje, R. Journal of Computer Assisted Learning. v10 n2 p81-92 Jun 1994.

N96-234 TITLE: Improved Missile Positioning, Attitude Sensing and Targeting (IMPAST) Using the Global Positioning System (GPS)

OBJECTIVE: Improve the probability of kill (Pk) of a 5-inch air-to-surface defense suppression missile by utilizing advances in GPS and processing technology.

DESCRIPTION: Air-to-surface defense suppression weapons that prosecute radiating threats (such as the SideARM missile) are often subjected to emitter shutdown or other countermeasure techniques that cause the weapon to proceed inertially based on the last known position of the emitter. The use of sophisticated receivers and processing technology to locate an emitter based on its radio emissions becomes useless if the target stops emitting. IMPAST will provide a 5-inch defense suppression missile with highly precise GPS information to eliminate the need for an autopilot and inertial navigation system and greatly improve the chance that the missile will strike the target even if shutdown occurs.

PHASE I: Provide a feasibility study to assess the potential increase in effectiveness of a 5-inch missile using IMPAST. The contractor will also create a notional design of IMPAST that will consider the advantages and limitations of GPS and the constraints of a 5-inch missile.

PHASE II: Develop, test and demonstrate the IMPAST system in a missile hardware-in-the-loop configuration.

PHASE III: Produce the IMPAST system demonstrated in Phases I and II and retrofit existing missiles. The transition will be to the SideARM missile program.

COMMERCIAL POTENTIAL: Navigation and autopilot systems in commercial aircraft.

N96-235 TITLE: Optimal Resource Allocation in a Distributed Computing Environment.

OBJECTIVE: A methodology is sought for performing optimal computing resource allocation in a distributed computing environment and reconfiguration for fault tolerance.

DESCRIPTION: In an environment where computing resources are plentiful and not all being used all the time, it is possible to distribute processes so that they complete faster and a better utilization of the computing resources is accomplished (most resources are used most of the time, instead of a few all the time). Assuming a Common Object Request Brocker Architecture (CORBA) environment, the desire is to, effectively and with as little overhead as possible, automatically assign processes to the least used resources.

PHASE I: Conduct a feasibility study and identify the system requirements and necessary technologies for performing the resource allocation. Study the potential performance improvements within a simulation environment and provide approaches for implementations in a networked workstation environment.

PHASE II: Implement a prototype that demonstrates the concept, utilizing the latest CORBA release and a number of networked UNIX workstations.

PHASE III: Implement the prototype to operate in a shipboard environment, addressing the necessary security issues.

COMMERCIAL POTENTIAL: Commercial applications of this technology would be used for weather prediction computations, stock market prediction, risk analysis, and modeling and training simulations.

REFERENCES:
1. "Universal Networked Objects", OMG TC Document 94.9.32, September 28, 1994.
2. Umar, A., "Distributed Computing and Client-Server Systems", Prentice Hall, 1993.

N96-236 TITLE: Enhanced Target Movement Prediction.

OBJECTIVE: A methodology is sought for predicting enemy units movement/actions based upon the past behavior of the units and actions of correlated units.

DESCRIPTION: A proof-of-concept is sought for developing state-of-the-art algorithms capable of learning an internal representation of an enemy asset through observation of historical movements/actions. This internal model should then be used to predict enemy asset movement and actions (or intentions). Since several courses of action could be probable, a set of movement/actions with associated probabilities should be calculated. This involves the development of a model of a highly

non-linear system (enemy asset), highly correlated with an external highly complex system (other units and terrain) based on relatively few observations. This work will involve learning internal representations of simple agents followed by terrain interaction and correlated multi-agent movements. A prototype system would be developed in C or C++ (commercial requirement) that would run on equipment consistent with Navy combatant computing architectures.

PHASE I: Conduct a feasibility study and identify requirements and technologies necessary for performing movement prediction. Study the time-performance requirements and provide approaches for obtaining real-time performance.

PHASE II: Implement a prototype that demonstrates the concept and provide a graphical user interface based on X11 and Motif for demonstrating the concept.

PHASE III: Examine the potential for enhancing the prototype by interfacing it with existing and under development military systems and test it using data where past, present, and future actions are known, so the predictions obtained can be compared with a real-life scenario.

COMMERCIAL POTENTIAL: Search and rescue operations, distributed interactive video games, entertainment, law enforcement.

REFERENCES: "The Tactical Movement Analyzer", NSWCDD/TR-94/99.

N96-237 TITLE: Object Recognition and Tracking at Video Rates

OBJECTIVE: A methodology is sought for performing object recognition and tracking, in real-time, using video imagery at 30 frames per second.

DESCRIPTION: Object/Target recognition is important and has many applications. Much effort is currently being put into recognizing objects in still images and some solutions are surfacing. The idea of using video for object recognition is not new, but is much more complicated due to the motion of the camera and of the object. In addition, the number of frames that must be processed in real-time present a huge processing task. However, the use of video has certain advantages in image processing that can be exploited.

PHASE I: Devise a method for detecting and tracking objects in video sequences. After an object is detected it is classified with regard to a set of known object types. In addition the capability to update this list of object types during operations should be provided.

PHASE II: Implement the method and demonstrate the capabilities, by operating on video sequences. The equipment to be used will be standard off the shelf products, compatible with the Navy tactical computer equipment. Software will be developed in C and C++, with X-window and Motif user interfaces and following all the ANSI standards. Following these standards will make porting to different UNIX systems easier.

PHASE III: Integrate the prototype into a fielded system.

COMMERCIAL POTENTIAL: Commercial applications of this technology could be used in security systems, automated product inspection, intelligent vehicles, video database querying.

REFERENCES:
1. A. Murat Telcalp, "Digital Video Processing," Prentice Hall, 1995.
2. Makoto Nagao and Takashi Matsuyama, "A Structural Analysis of Complex Aerial Photographs," Plenum Publishing Corporation, 1980.

N96-238 TITLE: More Effective Employment of Precision Guided Missiles (PGMs) with the inclusion of Weather Data

OBJECTIVE: Increase effectiveness of PGMs by including forecasted and insitu weather data integrated with aircraft sensed weather. Understand the availability, confidence of existing weather data and translate this scientific data to formats and displays easily understood and applied to weapons planning.

DESCRIPTION: Over 47% of the sorties in Desert Storm were effected by weather. PGMs must be more accurate, and minimize collateral damage. Historically the weapons community and the Meteorology and Oceanographic (METOC) community have been independent, resulting in very good meteorological models and weapons; however a lack of understanding exists on the relation between the two and how to best exploit the large amount of weather data to better employ PGMs. The

worst case is degradation in weapons performance (Tomahawk Anti-Ship Missile degraded by 50% in rain) to unnecessary restrictions due to mission planning artifacts (Tomahawk Land Attack Missile day types). Although we cannot change the weather, we believe we can decrease the amount of sorties lost to weather by using weather data in the planning process. By applying confidence factors to weather data, PGMs can be planned more confidently. Finally data enroute and over the target can greatly enhance the planning process if this data can be processed timely.

PHASE I: Design and implement a study which determines how weather data can be used; estimates increase in effectiveness of PGMs; outlines simulations and models to verify effectiveness; and outlines how forecasted, real-time and aircraft sensed weather data can be translated into a format which can be used by weapons planning. Outline how weather data could be efficiently transmitted into existing mission planning systems. This effort can be applied to all PGMs; however, to scope this project Joint Stand Off Weapon (JSOW) has been chosen.

PHASE II: Develop algorithms and modeling for integration of weather data into JSOW mission planning. Develop scenarios and conduct simulations (possibly reanalyzing Desert Storm) to determine increased effectiveness by incorporation of weather information into PGM planning.

PHASE III: Integration into a JSOW Mission Planning Module hosted on the Tactical Aircraft Mission Planning System.

COMMERCIAL POTENTIAL: Point specific forecasts for civil use.

N96-239 TITLE: New Polymeric Material for Propulsion Systems

OBJECTIVE: The objective of this program is to synthesize and scale-up polymers useful in propellant formulation or case liner material. These polymers will provide performance, insensitivity, and demilitarization advantages for the next generation of propulsion systems.

DESCRIPTION: This project involves polymer synthesis and scale-up, process optimization, propellant formulation, and motor demonstration.

PHASE I: The first part of the program will involve the design and synthesis of new polymeric materials for use in propellants. These materials will provide good compatibility with new oxidizers (i.e., CL-20,ADN, etc), superior mechanical strength, and good bonding properties. The materials should be scaled up to 5-lb quantities for preliminary evaluation in propellant formulations.

PHASE II: The second phase of the program will involve manufacturing/production technology of this new family of polymers, including synthesis process optimization, waste minimization, and cost reduction. The best candidate will be screened, and those that exhibit the desired properties in propellant formulation will be selected.

PHASE III: During the third phase, large production capability of these polymers will be demonstrated through a safe, low cost, and environmentally clean process; the merit of using this polymer in two full-scale propulsion systems will also be demonstrated. Motor firing and full-scale IM tests of these systems will be conducted.

COMMERCIAL POTENTIAL: These new polymers can be applied to space shuttle solid boosters and satellite launcher booster systems. The synthesis methodology and manufacturing technology can be applied to other industrial applications such as adhesive and paint/coating materials.

REFERENCE:
1. Navy IM Instruction 2105
2. Richard S. Miller. "Advancing Technologies: Oxidizers, Polymers, and Processing," published in the proceedings of AIAA 30th Joint Propulsion Conference and Exhibit, July 1994.

N96-240 TITLE: GPS Based Formation Control

OBJECTIVE: Develop a Global Positioning System (GPS) based implementation for formation control in vehicles.

DESCRIPTION: The Global Positioning System (GPS) provides precise location information to properly equipped vehicles. The intent of this proposal is to develop an application of GPS technology which will provide a real time method of determining the relative location of two GPS equipped vehicles such that the vehicles are able to maneuver relative to each other without reference to additional positioning data. The effort includes a study of the architecture and requirements of a system which will

allow relative maneuvering with confidence with separations (of the nearest points on the two vehicles) as low as one meter.

PHASE I: Phase I should result in a detailed conceptual design, analysis and proof of concept.

PHASE II: Phase II consists of prototype development, demonstration, validation and hardware delivery.

PHASE III: A Navy funded Phase III is expected.

COMMERCIAL POTENTIAL: For commercial use, the current aircraft collision avoidance systems could be improved by an accurate method of determining real time relative position and rates of closure. Any operation of multiple vehicles in proximity, could be automated, producing gains in efficiency. As the use of GPS for location expands into automobiles, a similar system could be developed to assist in ground collision avoidance.

N96-241 TITLE: Interdigital Deposition of Highly Conducting Polymers for Electrochromic Window Application

OBJECTIVE: Improve the switching speed and contrast ratio of the electrochromic switch by incorporating via interdigital electrochemical deposition very highly conducting polymer onto an area consisting of gold grid lines on a poly (tetrafluoroethylene) (PTFE) based substrate.

DESCRIPTION: Electrically conducting polymers show great promise for the use as electrochromic windows in many regions of the electromagnetic spectrum. The particular application being studied is based upon the conducting polymer's ability to switch from a conducting to a non-conducting state.

PHASE I: Provide a feasibility study to carry out selected interdigital electrodeposition onto model gold/PTFE model substrates and incorporate the deposition of these materials into the electrochromic switch.

PHASE II: Provide a prototype/demonstration based on the results of Phase I and specifications which will be provided.

PHASE III: Transition electrochromic switches to fleet and industry.

COMMERCIAL POTENTIAL: Polymers with higher conductivity will be available for electrochromic window applications, both military and civilian.

N96-242 TITLE: Ability to Predict Scene Based Algorithm/System Performance

OBJECTIVE: To develop a methodology and metrics which enable estimation of the maximum performance that a suite of algorithms used for automatic target recognition (ATR) can achieve for a given scene, as well as to be able to predict the maximum performance of individual algorithms in the ATR suite.

DESCRIPTION: Autonomous surveillance and weapon applications require the ability to perform ATR on data obtained from a number of sources including imaging infrared, synthetic aperture radar, and inverse synthetic aperture. At present ATR systems have been built which rely upon physics models of the targets, templates, and a number of other schemes. Techniques used to implement ATR range from neural network classification directly from the data to systems as complicated as building edge detectors, segmenters, boundary completion algorithms, feature extractors, pattern classifiers, and finally identification. The algorithms generally employ tuning parameters and it is not evident given the non-linear and feedback aspects associated with ATR suites that optimization of individual algorithms within an ATR suite is equivalent to optimization of the ATR suite itself. it is also desirable to be able to assess the maximum expected performance of the ATR suite given a particular scene. Adequate metrics to describe the performance of individual algorithms within an ATR suite not been identified. For example, in a given scene whose signal to clutter and signal to noise levels are known with a restricted class of targets which are to be identified what is the preferred implementation of edge detection in general, and in the context of the suite itself.

PHASE I: Contractor is to use an existing ATR suite which they have developed or can be obtained from sources including the government. Contractor is to develop a methodology which enables identification of metrics which can be used to assess individual algorithms in the ATR suite as well as system performance.

PHASE II: Contractor is to use algorithm suite in conjunction with data to implement, assess, and refine the methodology they have developed. Key products to be demonstrated shall include assessment of individual algorithms within the suite, tuning of algorithms based upon scene content, assessment of the expected performance of the ATR system itself given current scene content, tuning of the overall system given scene based information, and the ability to dynamically configure the ATR suite given scene based information. In addition, the methodology and the metrics used must be documented. Deliverables shall also include functional computer code which implements the methodology.

PHASE III: A number of programs exist within the government which rely on ATR including Cruise Missile, Real Time Retargeting, Integrated Air Deployed Strike Surveillance, Combat Idea, Wide Area Surveillance, and Model Driven ATR.

COMMERCIAL POTENTIAL: ATR like systems are required in production facilities for rapidly identifying faulty parts and diagnosis of failures in the manufacturing process. The techniques developed for military ATR applications are rapidly identifying faulty parts and diagnosis of failures in the manufacturing process. The techniques developed for military ATR applications are directly applicable to manufacturing. The methodology developed here is closely related to the methodology required to achieve real time planning and optimization for flexible manufacturing applications.

REFERENCES: Robert M. Haralick, "Performance Characterization in Computer Vision", CVGIP: Image Understanding, Vol. 60, Number 2, pp 245-249, September 1994.

N96-243 TITLE: Improve Thermal Shock Resistance of Sapphire

OBJECTIVE: Develop crystal growth modifications and/or surface treatments to improve the thermal shock resistance of sapphire without degrading infrared optical quality.

DESCRIPTION: Sapphire is desired as an infrared-transmitting window or dome on high speed missiles because of its excellent optical and mechanical properties. However, currently available sapphire cannot withstand the thermal shock associated with certain high speed missile flights. It is believed that the critical weakness in sapphire is loss of strength at elevated temperature during compression on the c-axis of the crystal. The purpose of this effort is to improve the ability of sapphire to withstand high heating rates without fracturing. This will enable sapphire to be used in more demanding missile applications. Possible methods for increasing the thermal shock resistance of the sapphire crystal include solid solution hardening, second phase hardening, surface modifications, and thermal treatments that affect crystal perfection. A successful treatment must not degrade the optical properties of sapphire and should not substantially decrease the thermal conductivity.

PHASE I: Demonstrate the feasibility of selected methods to improve the thermal shock resistance of sapphire. Work in this phase must include an experimental demonstration of improvement of the strength of sapphire at elevated temperature.

PHASE II: Thoroughly evaluate methods identified in Phase I. Prepare a sufficient number of coupons and conduct a statistically significant number of tests to measure key properties of improved sapphire. Properties include flexure and compressive strength of sapphire at 20, 300 and 600 C, and measurement of thermal conductivity over this range. Infrared optical measurements are required to demonstrate the effects of crystal modifications on transmission, emission and scatter. Conduct a sufficient number of growth runs to demonstrate that the proposed modification process can be accomplished in an industrial environment.

PHASE III: Transition improved growth and/or fabrication technology into a production facility. Build domes for wind tunnel testing and conduct such tests to verify increase in thermal shock resistance. Integrate dome into Standard Missile II Block IV airframe and conduct flight tests. The Standard Missile program is currently seeking such an improvement.

COMMERCIAL POTENTIAL: Improved sapphire will be available for military and civilian applications (such as process monitoring) involving high thermal loads on optical windows.

N96-244 TITLE: Nanometer Metal Powder Production

OBJECTIVE: Develop technology for industrial-scale production of nanometer metal and metal alloy powders.

DESCRIPTION: Nanometer (nm) powders are customarily defined as powders with particle sizes below 100 nm. Nanometer powders of carbon and metal oxides have found applications in a variety of commercial products: however, due to fabrication difficulties, nanoscale particle size metal and metal alloy powders have not been utilized in significant quantities. The primary reason for this low utilization is the lack of high quality powders at a reasonable cost. The desired outcome of this effort would be the development of a production technology with the ability of producing a wide range of nanometer metal and metal alloy powders. These powders would have a narrow particle size distribution and a low level of contamination. The goals for production technology would include a tunable mean particle size between 100 and 5 nanometers with 90% of the particles within ± 3 nanometers of the mean. While minimal contamination of these powders is critical to many of their potential applications,

others may require a passivated form of the material, and significant attention should be focused on this aspect of nanosize powder production.

PHASE I: The awardee will demonstrate an ability to produce at least three nanometer metal powders, one of which will be aluminum. As part of this demonstration, particle size and distribution control should be exhibited, along with the ability to passivate the aluminum powder. Additionally, a design and plan for the construction of a small-scale production unit (batch or continuous) with the capability to produce between 1 and 2 kilograms of powder per day shall be prepared. This plan and design will be implemented during Phase II.

PHASE II: Implementation of the plan developed in Phase I should be accomplished within the first 9 months, with the remaining time used preparing powders of various metal and metal alloys to demonstrate the capability and evaluate scale-up considerations while providing materials for characterization, experimentation, and market development. Furthermore, during this phase, both should be developed for the third and last phase of this effort. These plans should include a market analysis, industrial plant design, and potential non-federal sources of funding.

PHASE III: The financial and technical plans developed in Phase II should be implemented during this phase, along with construction of an industrial capability. The plant constructed during Phase II will continue to produce powders for further experimentation, and market and product development.

COMMERCIAL POTENTIAL: The commercial applications for materials produced from these powders include: electrically-conductive adhesives and polymers, powder metallurgical products, wear-resistant materials, superconductors, high temperature materials, etc. According to a study by BUSINESS COMMUNICATIONS CO. INC. entitled "Advanced Ceramic Powders & Nano-Sized Ceramic Powders," by the year 2000, the US market for advanced ceramic powders will reach $1.1 billion. While this may not correlate directly to nanometer metal powders, it could serve as an indication of the commercial market potential.

REFERENCES: "Nanopowders may extend PM parts' function" MPR Feb. 1995 pg 18-20. "Nano-Sized Ceramic Powders" Journal of Thermal Spray Technology, Vol 4(1), March 1995, pg. 15.

SPACE and NAVAL WARFARE SYSTEMS COMMAND

N96-245 TITLE: UHF-SHF Flat Panel (Planar) Antenna Arrays

OBJECTIVE: To design, develop, and demonstrate the capability of reconfigurable, Flat Panel Antenna Arrays to provide the submarine with a steerable, highly directive radiation pattern to support HDR (High Data Rate) UHF-SHF COMMS (ultra-high thru super-high frequency satellite communications) links.

DESCRIPTION: The submarine navy is currently investigating the feasibility of adding several additional communication bands to its present COMMS suite. Included in this review are such bands as VHF (very high frequency), VHF/UHF SATCOM CEL TEL 9 cellular telephone), JTIDS (Joint Tactical Information Distribution System), and numerous microwave SATCOM bands requiring HDR performance. Specifically, existing, Flat Panel, Antenna Array technology shall be applied to provide the above functions via an antenna assembly package adaptable to the submarine mast (preferable) or sail. The development may utilize a sandwich construction of frequency selective surfaces (FSS) for enhanced performance.

PHASE I: Develop several designs that approach meeting the objectives with different performance emphasis. Select one antenna design and deliver Level I (conceptual) drawings and schematics for a Phase II development that will optimize the link performance to be achieved within the limited submarine space available. Additional steering via mechanical means is an option.

PHASE II: Develop and build a feasibility/brass board model of the selected Flat Panel Antenna design. The resulting structure shall be sufficiently robust to withstand RF performance testing on outdoor antenna ranges, including the measurement of array pattern, gain, and impedance.

PHASE III: Build a Flat Panel Array for mechanical, as well as electrical, evaluation. The array shall be housed in a pressure proof package and shall be suitable for submarine installation and sea test evaluation.

COMMERCIAL POTENTIAL: The frequency range and flat configuration of the Flat Panel Array (as opposed to conformal array) make the design appropriate and adaptable to many mobile platforms.

REFERENCES: Kummer, Wolfgang H., Basic Array Theory, Proceedings of the IEEE, January 1992, p. 127-140.

N96-246 TITLE: Electro-Optics Window for Shipboard Application

OBJECTIVE: Develop large (>20" diameter) optical laser windows capable of operating in the harsh marine environment as part of a Naval weapon system and with the potential for other commercial maritime and space applications.

DESCRIPTION: The US Navy has identified a number of missions for which electro-optics, lasers and directed energy (DE) weapons are considered to add significant value to the conduct of prompt and sustained operation at sea. The beam director of such systems requires an external window. The window material to be developed must have the following properties: High optical transmission from Ultra Violet (UV) to the Mid-Infrared (MIR) and possibly in the Long Wave Infrared (LWIR) spectral range; an absorption coefficient < 0.04 CM-1 from 0.4 micron to 6 microns and 8 to 12 microns; high mechanical strength (young's modulus > 60 Gpa, rupture modulus > 6000 psi); a high resistance to water attack; and High material homogeneity, free from internal defects i.e. bubbles, seeds, and striae with low internal scattering. This program should also demonstrate the manufacturing technology necessary to produce window blanks up to one meter in diameter.

PHASE I: Demonstrate sub-scale window technical feasibility.

PHASE II: Develop the casting capability and cast a large (about one meter in diameter) window.

PHASE III: Demonstrate cost effective manufacturing approach.

COMMERCIAL APPLICATION: NASA and the private sectors are in contact with SPAWAR regarding the application of this window material in satellites, commercial aircraft and other high heat with no image distortion applications.

N96-247 TITLE: Enchanced Infrared Images of Pop-up Targets

OBJECTIVE: Develop low cost compact adaptive optics system to correct atmospheric aberrations by integrating such a system with existing infrared focal plane array cameras for mast mounted ship board application.

DESCRIPTION: Cruise missiles flying close to the surface of the ocean, un-detectable by the radars, can be seen by infrared and visible cameras. The images of such observation are severely hampered by the atmospheric turbulence, particularly for targets cruising only a few feet above the ocean waves. Turbulence and local temperature and humidity variations cause air density variation and consequently changes of index of refraction of the air. The index of refraction variations strongly influence the imaging wavefront. The random motion of a camera image is a direct result of intensity fluctuations (Scintillation). The time integrated images of existing camera systems are blurred because of time varying random intensity concentrations in the viewing media. Modest wavefront corrections would alleviate the scintillation and provide crisp clear view of the target. This program should also lead to the demonstration of this enhanced imaging system at sea.

PHASE I: Demonstrate technical feasibility.

PHASE II: Develop adaptive optics system capable of correcting the atmospheric effects.

PHASE III: Develop a plan for production and demonstrate cost effective manufacturing approach.

COMMERCIAL APPLICATION: Once developed, this system can be used by the Police and law enforcement officials, coast guards, NASA, and other commercial application.

REFERENCES: Focal plane array infrared and visible cameras exist. Development and integration of an adaptive system with the cameras are envisioned which allow for scintillation corrections.

N96-248 TITLE: All-Software Global Positioning System (GPS) Receiver

OBJECTIVE: Concept design and demonstration of a digital GPS receiver which processes GPS Satellite measurements non-real time providing a minimal time-to-first-fix all in view capability GPS receiver.

DESCRIPTION: GPS applications which require either direct Y encrypted signal acquisition or to minimize acquisition times, utilize highly accurate time information or will require receivers with thousands of correlators per channel. An all software design could utilize optimal tracking and navigation strategies which are difficult to implement in existing hardware based designs. The proposed receiver design would process GPS measurements in non-real time and would significantly improve GPS AJ performance. An all in view satellite approach would be used to maximize measurement availability and provide measurement integrity.

PHASE I: Design trade-offs will be necessary to determine the optimal tracking and navigation strategy for use in a non-real time processing environment. The benefits of matching tracking loop and navigation Kalman filters bandwidth will be considered. Coherent data demo modulation techniques will be utilized to provide optimal signal to noise ratios; trade-offs in terms of performance gains versus computational burden will be assessed. System level design requirements will be formulated and translated into software requirements. A survey of off the shelf digital receiver front end processors will be conducted and a module selected which meets system requirements. Processing algorithms will be coded and tested.

PHASE II: The receiver front end processor will be integrated with the processing algorithms. A concept demonstration using GPS satellite simulators in a controlled, laboratory environment will be performed

PHASE III: System will be ruggedized and tested aboard an operation platform.

COMMERCIAL POTENTIAL: Can be directly used in low power and cost GPS applications.

N96-249 TITLE: High Resolution Time-Frequency Representations

OBJECTIVE: The objective is to determine the feasibility of increasing classification capability for signals of interest to IUSS by using high resolution time-frequency.

DESCRIPTION: The standard displays for detecting and classifying targets in IUSS are the Lofargram and the Correlogram. These images are based on the Fourier transform and must trade off resolution in the time and frequency directions. Improved time-frequency displays have been shown to allow better classification, although they may not have merit as detectors. This work is concerned with further improving the resolution of time-frequency displays to achieve the maximum classification capability possible. Enchancements of existing time-frequency displays, or entirely new techniques, are desired. Prospective offerors should propose enhance approaches to display data and develop the metric for Phase I.

PHASE I: Investigate the feasibility of one or more high resolution time-frequency displays by processing data sets of interest to IUSS. Appropriate IUSS data will be provided. Develop a metric to evaluate these displays.

PHASE II: Implement one or more high resolution time-frequency displays in hardware and software suitable for an IUSS site.

PHASE III: Installation at an IUSS site.

COMMERCIAL POTENTIAL: The chosen technique can be used to resolve, classify and characterize interfering signals in seismology, medicine and ultrasonic non-destructive evaluation as well as in IUSS.

REFERENCES: IEEE Signal Processing Proceedings.

N96-250 TITLE: Automatic Feature Combined Track-Detect-Localize Technique

OBJECTIVE: The objective is to define and evaluate innovative technique for surveillance systems that combine tracking, detection and clustering/localization functions into a single near optimum contact localization capability that establishes feature contact formation in the presence of clutter signals. This includes algorithms which combine contact signature and kinematic characteristics to support classification.

DESCRIPTION: The increasing emphasis on shallow water, near land theaters of operation has introduced a dense and dynamic active and passive acoustic directional interference environment. This environment requires multimode acoustic feature extraction on large quantities of data. The success of contact classification and multi-platform/scene (contact) data fusion will depend on the ability of sensor systems to automatically detect, extract and associate large quantities of acoustic (passive and active) features into contact data clusters localized at time intervals in three dimensional scene coordinates. In the past localization analysis has been applied to a small subset of detected and at least partially classified data. The approaches to this topic should consider optimal approaches to automatically localize acoustic source features or events as part of the track/detect and contact formation process prior to classification decisions. The approaches should consider but need not be limited to Bayesian techniques for combining contact frequency, bearing and time robust tracking techniques with field information. Maximum use should be made of all available environmental parameters and their associated statistical uncertainties along with deterministic information. Proposals should address prototyping tools and other productivity tools to be used by the offerors.

Classification of source specific background acoustic signals will enhance the ability to distinguish between signals of interest and those signals which naturally or normally occur in a region. Such analysis will significantly reduce the false alarm

rates. Clutter signals include those generated from biological sources (i.e. snapping shrimp and migratory whales) and from man-made sources (i.e. drilling rigs and fishing fleets). Specific processing such as DEMON processing can be used to classify contact on non-interest. Specific approaches are required that consider all components. Proposals must consider all components of the signal received from dynamic contacts wherein bearing, frequency and signature content vary significantly. The contact track must be exploited to support both classification and localization.

PHASE I: Define and develop an algorithic processing flow (chain) of proposed techniques. Implement a software simulation of critical algorithm functions to prove the concept with recorded sea data. Provide preliminary test results demonstrating the feasibility of the proposed algorithm. A rapid protyping software development environment is encouraged.

PHASE II: Develop a complete software processing chain suitable for testing large quantities of recorded sea data on a Navy selected sensor system and validate the approach. Develop the software processing chain as a prototype laboratory based system. Provide a detailed algorithm and software description and user's manual.

PHASE III: The successful topic results of this research will be transitioned to SURTASS/LFA and ADS programs.

COMMERCIAL POTENTIAL: Automatic Tracking/Detection/Localization for improved feature association and contact classification of merchant ships, fishing vessels, contraband shipping and biological sources.

REFERENCES:
1. IEEE Signal Processing Proceedings.
2. Mission Needs Statement for Undersea Surveillance in Littoral water of 18 March 1993.
3. RIPPEN for rapid prototyping.
4. GMP for rapid prototyping (alpha version with minimal documentation available from SPAWAR PMW 182).

N96-251 TITLE: Passive Acoustic Transient Detection and Analysis of Mine Operations

OBJECTIVE: Develop a software tool using statistically based signal processing methods for signal feature extraction to detect and analyze the acoustic signature of airborne and surface mine deployment operations.

DESCRIPTION: Mine deployment operations, whether by ship, boat, aircraft or submarine, have characteristic acoustic signatures (i.e., water entry, chain payout, and bottom strike). Signatures can be recognized through the extraction of features from a waveform or image. Proper distinction between mining operations, mine fields, mines, and background noises can lead to fast response by covering forces and possible neutralization of the mining force.

Methods are needed to automatically detect and analyze mine deployment operations, mine fields, and mines. A method to consider is the Karhunen-Loeve Expansion eigenfunctions and eigenvalues from a series of sample waveforms and/or images. Examination of alternative algorithms besides the Karhunen-Loeve Expansion is encouraged.

PHASE I: Identify characteristics and features of transient acoustic signal characteristic with respect to type of mine, laying method, depth, distance from surf zone, mine fields, mine laying craft signatures, and stage of the mine deployment evolution. If using the Karhunen-Loeve Expansion eigenfunctions and eigenvalues, then develop and analyze alternative algorithms to statistically generate the Karhunen-Loeve Expansion from sample waveforms and images. Rapidly prototype and demonstrate a software tool using the best of the identified algorithms.

PHASE II: Develop the acoustic model of mine deployment operations to analyze the Phase I algorithms. In addition, design, build, and demonstrate signal processing algorithms as based on the Phase I model. This effort will be hosted on a SPARC C/Unix system with required special processing boards. The prototype and model will be tested using appropriate active or passive data sets.

PHASE III: Design and build an advanced development model. Conduct laboratory and field tests.

COMMERCIAL POTENTIAL: Techniques and equipment developed in this effort could be applied to other passive monitoring activities, such as coastal surveillance for drug interdiction and for detection of illegal commercial fishing activities. There are also a wide range of commercial applications in the fields of education, medical image processing, diagnostic systems and automated image compression for high definition transmission and data networks.

REFERENCES: IEEE Signal Processing Proceedings.

N96-252 TITLE: Development of Performance and Traffic Adaptive Management Tool for High Performance Communications Networks

OBJECTIVE: Develop a computer software based prototype network-management tool which dynamically and adaptively allocates the resources of a communications network and adjusts the parameters of the network access and control algorithms to ensure continuous high-performance command and control operation even when abrupt changes take place in the network traffic/ service loading and distribution scenarios.

DESCRIPTION: Modern Navy local area networks and associated multi-access radio channels are configured to operate in a distributed application environment and to support a wide range of real-time and non-real-time services in an integrated fashion. Such networks must also carry Navy command and control messages through the effective assignment of message priorities. The shared communications network resources must be effectively allocated to ensure that each service class is guaranteed its required quality of service measures. It is essential that high performance tactical (real time) networks used for mission critical applications provide each service class its required performance guarantees even under dramatic changes in the system traffic/service loading, mixture and distribution scenarios. Currently, the existing network management system engages in monitoring and collecting traffic, utilization and performance data and in its display. It also at times allows the user to reconfigure the system, change flow control parameters, and reallocate channel resources, based on manual inputs provided by the user. No tool is currently employed to automatically mediate between the monitored state information and the ensuing action required. As network systems become more geographically distributed, supporting a constantly varying distributed real-time operation in an integrated-services environment, it is critical that the network management system employs a performance and traffic management tool which is used to dynamically allocate system resources and adjust the parameters of the network control algorithms. Communications networks to be controlled involve local area networks and associated multi-access radio links. Included are connectionless networks (such as interconnected and switched Ethernet, FDDI, TCP/IP router based networks), connection oriented architectures (such as Frame Relay and ATM), and multi-access radio channels (such as those using TDMA, DA/TDMA, random access, polling and other hybrid multiple access protocols). Such management processes can affect simultaneously different network layers and sublayers (such as physical, MAC, link, network, Internet work, transport, session layers) and different control mechanisms within each layer (such as flow control, congestion control, access control, error control, multiplexing, etc). The prototype tool to be developed should make effective use of existing analytically oriented tools and techniques for distributed real-time computer communications networks.

PHASE I: Develop the models and the analysis and synthesis techniques, to be implemented in Phase II, for the proposed adaptive network management tool. Through the consideration of a number of different Navy network systems which include local area networks and their interconnections, and multi access radio links, demonstrate the effectiveness of the proposed management and control schemes and algorithms. To ensure a high performance tactical operation, it is critical that real-time services are accommodated at minimal message delay latencies and jitters.

PHASE II: Develop the computer software for the tool prototype, incorporating the dynamically adaptive algorithms and analytical models, using effective object oriented program structure and graphical user interface. Use simulations and analyses to demonstrate the ability of the tool to interact with network management systems to adjust system parameters and make resource allocations in an efficient and real time manner.

PHASE III: Anticipated future use in high speed Navy shipboard networks and multi-access radio links. Applications include: LHA upgrade; JMCIS; CVN78; SC21; Tactical Intelligence links; LPD 17; range operation centers; interconnected LAN shipboard and ground installations.

COMMERCIAL POTENTIAL: The tool sought should have commercial application to integrated communications systems that are either satellite based, local area network based or both.

REFERENCES: Copernicus...Forward, Naval C4I Implementation, SPAWAR, Arlington, VA 22245-5200

N96-253 TITLE: Requirements Management Assistant

OBJECTIVE: Develop and test a Requirements Management Assistant (computer based tool) which manages, updates and traces system level requirements for program managers.

DESCRIPTION: Design, develop, and test a Requirements management assistant which dynamically links MNS, ORD andA-Level specification requirements and corresponding test requirements. The requirements management assistant should have the following capabilities and features: Recognize requirements based on their lexical specification. Identify potentially linked

(subordinate or superior) requirements in different specifications. (An engineer will review and validate potential requirements linkages) Allow one to one, one to many, or many to one, linkages between requirements. Linkages should allow both simple or quantitative relationships between requirements Allow different types of information to be associated with each requirement and linkage. (e.g. Importance of the requirement, basis for goal and threshold values, risk, etc.) Allow specifications to be input from any popular word processing program and provide lexical based searches on requirements and associated information. Maintain version histories and flag potential requirements changes in one specification resulting from requirements changes in another specification. Be able to import and export data and to be integrated with system, hardware and software development tools like RASSP, CASE tools, etc.

PHASE I: Design and prepare a detailed performance specification for the requirements management assistant and propose scenario for testing the assistant. Provide cost and schedule estimates for building and testing the assistant.

PHASE II: Build, beta test and deliver a stand-alone requirements management assistant.

PHASE III: Integrate the assistant with RASSP and designated COTS-based systems engineering design automation tools for use in ADS, FDS, and SURTASS. Develop assistant upgrades identified by beta tests.

COMMERCIAL POTENTIAL: If this SBIR is successful, the requirements management assistant will probably be enhanced and marketed as a commercial product. Even if the assistant is not commercialized the technology developed under this SBIR will transition directly into other system engineering design automation tools.

REFERENCES:
1) Experience with the Application of Systems Engineering Tools Paper presented by John E. Cox at the 26-28 July Symposium of the National Council on Systems Engineering
2) A Survey of Systems Engineering Design Automation Tools presented by Dorothy Kuhn and Mark Sampson at the 26-28 July Symposium of the National Council on Systems Engineering.

N96-254 TITLE: Image Information Preserving Compression for LOFARGRAMs

OBJECTIVE: Develop an innovative information preserving compression metric for LOFARGRAMs and other IUSS image products and apply the metric to compression algorithms using IUSS data.

DESCRIPTION: The undersea surveillance systems operated by the Navy provide a wealth of acoustic data. One system for collecting and displaying this data is the Integrated Undersea Surveillance System (IUSS). IUSS produces an invaluable analysis tool commonly known as a LOFARGRAM as well as other products. The LOFARGRAM has its counterparts in all acoustic systems which can be used to correlate commonly held targets. Presently, these LOFARGRAMs are only distributed within the individual acoustic communities. Therefore, the purpose of this topic is to investigate image compression algorithms for LOFARGRAMs and other IUSS products (CORRELOGRAMs, etc.) which can dramatically reduce the size of the image files while preserving critical contact classification information thus making it practical to distribute these images to the fleet. Compression ratios (with minimal informational loss but completely preserved classification information) on the order of 1000 to 1 are required. This type of signal processing has not been attempted before on IUSS
image products. There are several display/analysis/correlation systems within the Navy and other services that could also benefit from this acoustic data. Unfortunately, a single acoustic image can be fairly large (on the order of 500 KBytes or larger). In addition, the communications paths through which this imagery might be distributed to the fleet are extremely bandwidth limited. Prospective bidders should propose specific approaches to developing a classification information preserving metric and select specific candidate algorithmic approaches for the Phase I.

PHASE I: Develop a metric to evaluate the preserved information content of the compressed data. At this point, we are only interested in qualitative results. Review all current image compression algorithms, techniques, and technologies to determine their suitability on representative LOFARGRAMs and CORRELOGRAMs. If a new algorithm needs to be developed, develop the algorithm and test it. IUSS data will be supplied for this testing. If the Phase I results are promising, refinement can be done in Phase II. Produce a final report documenting the Phase I results plus example of compressed and decompressed images for Navy evaluation.

PHASE II: Using the results obtained in Phase I, continue to refine and produce a metric with quantitative parameters. Apply metric to the selected/developed algorithm(s). Work with Navy acoustic analysts to verify that the compression/expansion process has not degraded key classification features of the image. Appropriate IUSS data will be provided. Implement a standalone software package within the National Image Transfer File format for use with the Joint Maritime Command Information System (JMCIS). In addition, perform the compression/expansion process and produce documentation for this package and test over established Fleet Communication Circuits to a variety of acoustic users afloat and ashore.

PHASE III: Apply the compression algorithms developed here to commercial image processing and IUSS systems acoustic images such as FDS, ADS, and SURTASS.

COMMERCIAL POTENTIAL: This topic has significant potential for commercial applications in the area of image processing since generalizing the information preserving metric to other data images types provides a needed capability that is not currently available. With the growth of electronic commerce and communications, large, digital images are increasingly being transmitted from one location to another. Compressing these images while preserving certain data/image information would save considerable time and money.

REFERENCES:

1. SBIR 94-094 Digital Compression and Error Correction for Video Images.
2. National Imagery Transmission Format (Version 2.0), MIL- STD-2500, 18 June 1993.
3. Principles of Underwater Sound/3rd edition , Robert J. Urick.
4. Digital Image Processing, by Raphael C. Gonzalez and Riochard E. Woods, Addision-Wesley, 1992.
5. Scientific Visualization, Techniques and Applications, K. W. Brooke et al., Springer-Verlag, 1992.
6. Jain, Anil K., Fundamentals of Digital Image Processing, 1989, Prentice Hall.
7. Mission Needs Statement for Undersea Surveillance in Littoral water of 18 March 1993.

N96-255 TITLE: Development of Adaptive Security and Software Applications for Programmable Intelligent Digital Equipment

OBJECTIVE: Develop an adaptive security module that can be integrated with future multifunctional, multiband programmable intelligent digital equipment. The adaptive concept of programmable digital radios needs to be extended to include image processing, fax, data and word processing applications such that military radio capabilities can be more integrated into secure information processing. The security module should include data separation, multiple algorithm manipulation, multiple hardware platform capability (PCMCIA, others), support current COMSEC and other general cryptographic algorithms and a key management overlay which includes symmetrical and asymmetrical capabilities.

DESCRIPTION: Develop an information security concept appropriate for multifunctional, multiband programmable intelligent digital equipment, develop an implementable design, demonstrate the feasibility of the design and demonstrate an integrated secure information processing capability in hardware and software that can be hosted in programmable intelligent digital equipment.

PHASE I: Develop an information security concept and a functional allocation design that shows how the concept could be implemented. The design should include a security module that can be demonstrated with information processing applications for programmable intelligent digital radios. The design must include interoperable COMSEC and be adaptive to differing access and confidentiality levels as found in the classified and unclassified but sensitive environments.

PHASE II: Complete the design, develop and test a prototype implementation of the security module that can be demonstrated in a programmable intelligent digital radio. Demonstrate the integrated prototype in Navy fixed and mobile environments. The demonstration environment could be a part of a Joint Warfare Interoperability Demonstration (JWID).

PHASE III: A successful prototype is expected to be incorporated into the new generation of Navy programmable intelligent digital equipment. Accordingly, develop a detailed commercialization plan that addresses how the product will be developed and marketed. The plan should include a realistic market analysis and assessment and the resources required to bring the product to market. The plan should also address how and when the resources required will be marshaled to bring the product to market.

COMMERCIAL POTENTIAL: This technology would have application for commercial privacy and information processing needs as an integrated module in commercial programmable digital radios and equipment.

N96-256 TITLE: A Mission Planning Trainer Module for IUSS Deployable Systems

OBJECTIVE: The objective of this topic is to demonstrate the feasibility of a low cost, method for rapidly training fleet operators in deploying Deployable systems. using software that will be portable across generations of Navy TAC computers.

DESCRIPTION: The Navy has recently taken great advantage of commercial computer technology to produce a standard family

of COTS desktop workstations and Command & Control software applications. Considerable cost savings have been realized in application program development through the use of pre-defined Application Program Interfaces (API) and a large library of general purpose routines. Innovative use of these techniques could provide a highly productive method of developing integrated computer-based training for these applications. Such an approach could use the application software itself to eliminate the need for expensive stand-alone trainer developments and classroom training. For deployables there is no time available in the time line for class room training of fleet mission planners.

PHASE I: Develop a design specification for the training module. Prototype a simple training example to demonstrate the use of cursors, charts, database manager, communications, acoustic models etc. to implement interactive training exercises for a student user.

PHASE II: Develop a full-featured interactive module for the deployables application. Demonstrate and document the software reuse and cost avoidance potential of this approach.

PHASE III: Develop a prototype and provide user documentation for deployable system users such as ADS and SURTASS.

COMMERCIAL POTENTIAL: This technology has vast applicability to the increasing number of commercial businesses which require extensive employee computer use. Examples include airlines, car rental companies, delivery services, banks and investment firms. There is increasing commonalty throughout the industry in operating system interfaces, windowing systems and database interfaces. These provide an excellent basis for integrated computer-based training for many applications both commercial and DoD.

REFERENCES: Mission Needs Statement for Undersea Surveillance in Littoral water of 18 March 1993.

N96-257 TITLE: Adaptive Beamforming for Littoral Waters

OBJECTIVE: The objective of this topic is to develop sonar signal processing which is suitable for the littoral environment which is characterized by heavy shipping and near-field acoustic propagation effects.

DESCRIPTION: The recent change in operational emphasis to focus on littoral scenarios has caused Navy ASW ships to operate in acoustic scenarios for which their sensors were not designed. A specific problem of interest is the detection scenario in which loud, nearby contacts obscure the targets of interest. The well known techniques of adaptive beamforming are effective in these scenarios, but only when ranges are great enough for the plane wave assumption to be valid, or when detailed range information is available. Techniques are required which achieve the noise rejection benefits of adaptive beamforming without requiring detailed positional knowledge of contacts in the field.

PHASE I: Develop an algorithm description for proposed near-field processing techniques. Demonstrate and quantify noise rejection and signal preservation behavior on simulated signals.

PHASE II: Implement a laboratory version of the processing techniques which can process real ocean acoustic data from a suitable sensor system. Develop performance measures and quantify the behavior of the near-field algorithms. Identify the important variables and sensitivities which are critical to algorithm performance.

PHASE III: Implement the developed algorithms for a selected Navy sonar system and conduct at-sea tests.

COMMERCIAL POTENTIAL: These processing techniques would be of interest to the seismic exploration and geophysics communities, which routinely encounter near-field effects. The techniques may also be applied to commercial fishfinding and object location sonars. Adaptive techniques are also widely applied to medical sensor systems in which near-field effects can be important.

REFERENCES: Cox, H. JASA, 1973 "Adaptive Mismatch..."

N96-258 TITLE: Robust Coding Scheme for Satellites (ROCSS)

OBJECTIVE: Prevent sudden losses of Direct Broadcast Satellite (DBS) signals due to small degradations in link performance.

DESCRIPTION: Information obtained from DBS systems currently in operation indicates higher than expected implementation loss when compared to theoretical performance. Examination of theoretical coding implementation shows a sharp dropoff which in actual operation results in a nearly total loss of signal for small degradations in link performance.

PHASE I: Determine potential coding schemes and rates which could be implemented in a DBS application and demonstrate theoretical performance using computer simulation, working specifically on the Pe versus Eb/No rolloff slope to identify the source(s) of loss.

PHASE II: Using the results of Phase I, execute a prototype model to demonstrate an optimum, robust coding scheme with linkage to live DBS data. Solicit the interest of potential commercial phase III partners/sponsors.

PHASE III: Proceed to production with applications suitable for military or commercial DBS sysytems.

COMMERCIAL POTENTIAL: Military applications will, by policy, use commercial DBS to the extent practicable, therefore commercial interest is inherent in any breakthroughs in performance and potential improvement in customer satisfaction.

N96-259 TITLE: Dynamic Selection of Reallocated Timeslots

OBJECTIVE: The objective of this topic is to improve the efficiency and effectiveness of operational TDMA networks

DESCRIPTION: Certain TDMA communications systems utilize networks that are designed from pre-planned operational scenarios. These scenarios estimate the number of potential users, user types, and individual/collective communication requirements. Estimated values are used by the TDMA network designer to preallocate system capacity to individual users by assigning them network time slots. Assigned time slots are used to transmit users own data over the network. Prior to activating a TDMA communications system, a network is selected from a library of networks which most closely reflects the current operation. Mismatches between estimated and actual network user values can result in unused time slots, over/under subscribed time slots among network participants, and less than optimal network operation.

PHASE I: Perform a feasibility study for development of a real-time system to perform a network loading analysis which has
the potential for use in dynamic time slot reassignment.

PHASE II: Use Phase I feasibility study results to develop application software and processes. Host software on VME hardware, and test prototype system. Conduct the test in a laboratory environment using a TDMA communications network.

PHASE III: Full development and production for commercial and military TDMA communication systems is envisioned.

COMMERCIAL POTENTIAL: Any commercial communications system which employs a networked TDMA architecture could benefit from this technology. Potential markets include satellite communications, cellular communications, and other wireless systems.

NAVAL SEA SYSTEMS COMMAND

N96-260 TITLE: Virtual Prototyping

OBJECTIVE: The OBJECTIVE of this topic is to develop a simulation system that replicates CAD/CAM/CAT tools for the sole purpose of synthesizing an engineering manufacturing development (EMD) model into a prototype that will simulate test parameters for stressing the system to both performance characteristics and environmental requirements preceding actual fabrication of hardware.

DESCRIPTION: Today's defense manufacturing uses prototypes and initial production units from limited production quantities to demonstrate design integrity and performance. This transition from EMD to full production phase offers opportunities to mitigate production risks and can be achieved through a synthesis of developing a virtual manufacturing environment that will reduce both risk and cycle time in arriving at a decision for production. The concept must address simulation of tests to stress the design. The virtual prototyping concept can significantly reduce management risk and reduce the number of engineering changes so costly in the production of weapons systems.

PHASE I: Design a system that offers the potential to be integrated into a virtual prototyping theory and sufficiently model it in order to demonstrate proof of concept.

PHASE II: Develop and demonstrate the Phase I design simulation model that can create the virtual prototyping for multiple applications.

PHASE III: Integrate the above demonstrated Phase II into AEGIS/NAVSEA efforts. Develop the standards and product specification, and use these standards to build one unit.

N96-261 TITLE: Oceanic Environmental Control

OBJECTIVE: The objective of this topic is to develop a system of sensors and readout capability to assess ocean plankton density used in determining marine life concentration to assist the Fleet in selecting test sites involving ordnance and or shock trials.

DESCRIPTION: Today the Fleet does not possess a reliable and independent method for determining environmentally safe exercise and test areas in U.S. coastal waters without the assistance of other Government agencies. Prior to proceeding with any development effort the project must be preceded by a market survey as well as a literature search of laboratory studies in order to optimize the engineering solutions for this project. Ultimately the system must be capable of sensing plankton that can be related to the identifiable species most likely to be feeding on these plankton.

PHASE I: Show feasibility through review of available data collected by government agencies and non-government entities regarding marine life migration and oeanic variables influencing marine life populations, sensors, etc. A literature search of science research projects is to be conducted concurrently. Design a simulation model that can create virtual environmental states.

PHASE II: Construct a proof of concept engineering model and demonstrate aboard ship.

PHASE III: Produce and market a viable product.

COMMERCIAL POTENTIAL: The technology can be implemented in the commercial sector in several management applications related to the fish industry, EPA regulations, and protection of endangered species.

N96-262 TITLE: Advanced Technology Information Interconnectivity

OBJECTIVE: The objective of this topic is to develop a set of licensed systems of controls and protocols interconnected to provide reliable and "user friendly" connectivity to both the Defense Information Infrastructure (DII) and the numerous information services unique to the DON sponsored initiatives.

DESCRIPTION: Industry has spent in excess of $1 trillion on information technology since the early 1980s. Today the National Information Infrastructure (NII) Act attempts to leverage the information that resides in various technology service organizations and provide greater access to the Public. In addition, the Defense Information Infrastructure and the Global Information Infrastructure provide opportunities to make accessible information in technological advances that can only be managed with a system of tools that will lend focus to the desired data. The selective data will advance the decision making process to mitigate risks. Ultimately the system must demonstrate the capacity to be applied in an environment that can capture large volumes of both literature and numeric information.

PHASE I: Conduct an investigation of current technological advances in information processing and management that will assist in the contractors ability to develop software and peripheral equipment requirements in an open architecture environment. Design a user friendly system to create tailored information searches.

PHASE II: Develop a prototype that demonstrates how DON (Department of Navy) users can be served by a user friendly system with the capability to create tailored information searches based on DON RD&A (DON Research, Development and Acquisition) requirements.

PHASE III: Develop the specifications for use by both the government and industry for the potential application of this user friendly system inclusive of security and protocols in a global network environment. Integrate into DON system.

N96-263 TITLE: Fast Room Temperature Cure Adhesives for Fiber Optic Connectors

OBJECTIVE: The OBJECTIVE of this topic is to develop an adhesive for fiber optic connector applications that meets all of the Navy fiber optic connector adhesive requirements and that cures at room temperature in less than 3 minutes.

DESCRIPTION: Navy standard fiber optic use a heat cured adhesive (per MIL-A-24792) to hold the fiber within the connector. The current cure cycle for this type of adhesive is 20 minutes at 120 degrees Celsius. An adhesive is desired that meets the same minimum levels of performance as the current adhesives, but does not require a heat source and which cures in a relatively short time (less than 3 minutes).

PHASE I: Perform a trade-off analysis comparing the potential and actual performances of adhesives from the different adhesive families. Provide a recommendation for the most likely adhesive family for which a product could be formulated to meet all of the Navy requirements. Develop several different adhesive formulations from the recommended adhesive family

and perform initial testing to characterize critical parameters of the different formulations.

PHASE II: Completely characterize each of the different formulations developed in Phase I and any additional formulations that could more closely meet the Navy requirements. Based on characterizations, develop an optimum formulation for the adhesive for Navy fiber optic material for compliance with MIL-A-24792. Provide adhesive samples to Bellcore and major U.S. connector manufacturers for evaluation.

PHASE III: Begin production of the adhesive material and sale to the U.S. Navy and commercial users.

COMMERCIAL POTENTIAL: The largest application of this product is in the commercial fiber optic connector market. Most of the connectors currently installed within the U.S. are fabricated with adhesives that require heat curing for 10 to 15 minutes. The fast room temperature cure adhesive will result in labor savings during connector installation in commercial applications as well as in Navy applications.

REFERENCES: MIL-A-24792

N96-264 TITLE: Develop Techniques for Use of Open System Architectures for Commercial Off-the-Shelf-Components

OBJECTIVE: Develop innovative methods, techniques and tools for
the system engineering of large complex computer-based systems using open system architectures for commercial off the shelf (COTS) components.

DESCRIPTION: Integrate the innovative methods, techniques, and tools with existing system engineering techniques to provide an seamless product. Capabilities addressed should include specification, capture, analysis, assessment, and system-level optimization. System engineering to insert COTS and open system architectures into existing systems should be emphasized.

However, many challenges exist in using COTS and open system architectures. The system engineering must be able to make intelligent design/implementation decisions. These challenges include: (1) determining the correct system partitioning for an open system architecture, (2) detailed definition of open system interfaces, (3) selection of components (including trade off assessments), and (4) assessment of non-functional system attributes (timing, reliability, security) within system with open system components,. In an evolving system, the system engineering must ensure top-level requirements continue to be met as open system architecture and COTS components are inserted into the system. The effort should augment existing system engineering techniques, methods, and tools wherever feasible.

PHASE I: The methods proposed should be demonstrated to show feasibility. The requirements and design of all tools should be presented. Additionally, critical risk areas of the design should be prototyped to show feasibility of the total approach.

PHASE II: Full scale development of the automated capability should be completed. Usefulness of the method and tool should be demonstrated on a sample test case to facilitate the transition of the products into Navy systems development.

PHASE III: Transitions into a current large-scale Navy programs for which the requirement (for either new development or system modification) are under development.

COMMERCIAL POTENTIAL: Since large systems in the commercial sector are made of many COTS components, the methods and tools developed will have high commercialization potential.

REFERENCES:
(1) MIL-STD-499B (Draft) System Engineering
(2) Open System Environment (OSE) Profile for Imminent Acquisitions (Draft), Developed by Information Processing Directorate, DISA.
(3) DoD Directive 5000.1, Defense Acquisition, 23 February 1991.
(4) DoD Instruction 5000.2, Defense Acquisition Management Policies and Procedures, 23 February 1991.

N96-265 TITLE: Three Dimensional Target Location from Video Images

OBJECTIVE: Develop algorithms to support the use of a video camera to establish the locations of objects in three dimensions.

DESCRIPTION: The Naval Surface Fire Support program sees great value in the use of low-cost video cameras to locate targets on the battlefield. Images would be gathered from cameras mounted on unmanned aircraft, dropped by parachutes, fired in

projectiles, carried by Marines, or placed in key positions. (If the camera is not moving, two cameras will be used to provide perspective to measure the third dimension.) These cameras will have their position and angles established with the Global Positioning System and a low cost inertial navigator. The inertial navigator will be calibrated by the GPS and receive its initial conditions from GPS, so it will not be any more accurate than the information GPS provides. The GPS will be operating in P(Y) code operation, but not in kinematic or other carrier-phase sensing mode. Within these constraints, frames of the video images will be tagged with the camera's position and orientation.

The SBIR effort must develop a system to deal with two problems: extraction of targets from the video frames, and conversion of the extracted target's 2-D position in the video frames into a 3-D position in GPS coordinates. Initially an operator will select a target from a video frame, and the system will then have to analyze subsequent images to locate the same target, extract a consistent position, and feed that position into the conversion algorithm. If the conversion algorithms also require positions of background points in the image, the extraction algorithm must select these background points automatically.
We want to locate both fixed and moving targets. For moving targets, velocity as well as position is needed.
The accuracy desired is 2 meters CEP location of the target with respect to a camera position, when operating at a range of 2 kilometers from the target. Achieving this accuracy will require more than simple triangulation because of errors in alignment of the low cost inertial navigator.
We expect to use compressed images and narrow communications bandwidth, so techniques that deal with individual snapshots preferred to those that require full motion video. The locating system can specify which frames it wants (that is, the frame timing is flexible, with 1/30 of a second or many seconds between frames). In some applications, the locating system will be able to specify the motion of the camera, but that will not be guaranteed. (For example, a camera on an unsteered parachute will not be controllable. In cases like this, the locating system should perform well unless the situation is degenerate and three dimensions can not be calculated mathematically.)

PHASE I: Develop algorithms for target extraction and position location, and demonstrate their performance on synthetic imagery of stationary targets.

PHASE II: Demonstrate the algorithms with real-world imagery, and extend them to moving targets.

PHASE III: Integrate the algorithms into a shipboard video workstation.

COMMERCIAL POTENTIAL: These techniques are directly applicable to geodesy and mapping, which currently relies on manual techniques with aerial photographs, referenced to high cost inertial navigators. There is particular demand in the area of site surveying at commercial properties, which require accurate location of all structures and elements, including landscaping, for zoning purposes and for environmental remediation. A similar need is in architecture and industrial design, which requires the surveying of existing conditions inside a building, for example equipment locations on a factory floor. These techniques also apply to factory automation and machine vision systems.

REFERENCES:
1. *"Longlook" Accurate Target Location with Low-Cost Gun-Launched Aircraft,* FY98 Advanced Technology Demonstration Proposal. (Available from NAVSEA PMS 429D, Mr. David L. Liese.)
2. Thomas S. Juang, "Determining Three Dimensional Motion and Structure from Two Perspective Images," in *Handbook of Pattern Recognition and Image Processing,* pp 334–354, (Eds) Tzay Y. Young and K. S. Fu, Academic Press, 1989.
3. Guna Seetharaman, "Dimensional Perception of Image Sequences", Chapter Three in *Handbook of Computer Vision,* edited by Tzay Y. Young. Academic Press, FL, 1994.

N96-266 TITLE: Develop Uplink Channels Within Military GPS Receivers

OBJECTIVE: Develop a method to communicate to a GPS equipped weapon through its GPS receiver.

DESCRIPTION: GPS equipped weapons are entering development and employment, but are currently not retargetable after launch, except through an external data link. We desire a way of communicating with a GPS guided weapon through its GPS receiver. An approach is desired that minimizes the additional equipment on the weapon, that takes advantage of the crypto-secure P(Y) code, and that does not undermine the GPS receiver's navigation and housekeeping functions. Data rates in the range of 500–5000 bits/second are needed, and reception of multiple channels by the weapon would be desired (for example, to support retargeting from the firing platform along with differential GPS corrections from a differential base station). The technique should not interfere with the firing platform's own GPS or use of GPS service by other users, and the technique should permit multiple users to communicate with their own weapons simultaneously.

PHASE I: Develop an approach to achieve this capability, along with estimates of cost impact to the weapon and to the firing platform.

PHASE II: Implement and demonstrate the data link.

PHASE III: Phase III transition is possible to many GPS-guided weapons, such as ATACMS, SLAM, or JSOW, but the most immediate transition would be to the NSFS five-inch guided projectile.

COMMERCIAL POTENTIAL: The techniques developed for this topic will be applicable to the many commercial GPS applications now emerging, particularly the Wide Area Augmentation System (planned to be implemented by 1997) and the FAA GPS Category III precision landing system. It will be applicable to any application where a system with a GPS receiver also requires other data: differential GPS navigation and surveying, Intelligent Vehicle-Highway Systems, and telemetry. The commercial GPS market is predicted to reach $2 to $6 billion annually in 1996. Additionally, more general applications of this SBIR topic exist in Code-Division Multiple Access techniques for cellular telephones, pagers, and mobile data applications

REFERENCES: *NAVSTAR GPS Space Segment/Navigation User Interfaces (ICD-GPS200)*, NAVSTAR GPS Joint Program Office, July 1991.

N96-267 TITLE: Electronically Stabilized and Deblurred Camera

OBJECTIVE: Produce a video camera that provides a stabilized, deblurred image electronically, in a highly integrated design that includes the imager, its support circuitry and the stabilizing and deblurring circuitry on one chip.

DESCRIPTION: The Naval Surface Fire Support program sees great value in the use of low-cost video cameras to locate targets on the battlefield. The cameras could be carried on a variety of platforms, including unmanned aircraft or parachutes; or carried by Marines, or mounted on their vehicles. In these environments, the quality of the camera imagery will suffer from blurring and image motion as the camera tilts. However, these platforms have lowcost inertial navigators that can provide angle rate information that can be used to stabilize the image.

This SBIR topic seeks a low cost, all-electronic solution to stabilizing and deblurring the video produced by the camera. We believe that new developments in imagers, such as the NASA Jet Propulsion Laboratory's Active Pixel Sensor, make it possible to produce an imager chip with a large number of pixels (for example, 1024 x 1024) within which a smaller image frame (for example, 640 x 400) could be steered to follow the image as the camera moves. For deblurring, a series of high-shutter-speed images would be adjusted into alignment based on the inertial navigator's angle rates and summed. The same process carried out over a longer time frame would enhance the low-light performance of the camera. If two frames were aligned and differenced, the camera would provide moving target indication. Additionally, the CMOS process used in the Active Pixel Sensor allows the support circuitry to be included on the same silicon substrate, which would allow tight integration of the stabilization circuitry with the imager's analog-to digital conversion and row and column readout process. (In its ultimate configuration, the camera would incorporate the low-cost silicon micromachined gyros, to provide the rate sensors on the same silicon chip, but that effort is outside the scope of this topic.)

PHASE I: Develop a design for a stabilized, deblurred camera with image integration and moving target indication, and demonstrate a brass board. A goal for the deblurring function is to provide an effective shutter speed ten times the frame rate. (That is, a $^1/_{300}$ second shutter speed in a $^1/_{30}$ second total exposure time.) Demonstrate its stabilization, deblurring, and moving target indication functions.

PHASE II: Fabricate an imager chip containing the light sensor and all support circuitry.

PHASE III: Produce a camera incorporating the stabilized imager chip, and demonstrate its performance on a live vehicle.

COMMERCIAL POTENTIAL: The commercial market for stabilized cameras is filled by the Steadycam (a heavy and expensive gyroscopically-stabilized film camera), Steadycam Jr. (a pendulum-stabilized rig for video or film cameras), and by moving-prism based stabilizers for the optics of video cameras. The electronically stabilized camera will be able to take a large portion of this market, in the home market as well as professional video, particularly news coverage. The camera's integration and moving target indicator functions are particularly valuable for remote security applications, to enhance performance in low light conditions and reduce data transmission needs and storage requirements for archiving. (Many security cameras observe empty hallways.) The very small size and low power consumption of an electronically-steered camera also make it suitable for boom and wire-flown application in coverage of live events and to achieve coverage from an otherwise inaccessible angle.

REFERENCES:
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2. Sunetra K. Mendis, Bedabrata Pain, Robert H. Nixon, and Eric R Fossum "Design of a Low-Light-Level Image Sensor with On-Chip Sigma-Delta Analog-to-Digital Conversion" *Proceedings of the SPIE vol 1900, Charge Coupled Devices and SolidState Optical Sensors III* (1993).
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5. "JPL Squeezes Camera onto Chip," *Military and Aerospace Electronics,* Nov 1995,-

N96-268 TITLE: Innovative Gun, Chamber, Breech Designs

OBJECTIVE: To develop an all-new gun, chamber, and breech concept that is consistent with large caliber, high rate-of-fire, short recoil gun systems that are likely to be fielded on future ships.

DESCRIPTION: Because of recent gun concepts for launching guided projectiles vertically without train and elevation control, additional design flexibility is available by which to optimize the remaining gun components for this mission. One of the primary design requirements is that of maximizing barrel length within a fixed packaging dimension. This requirement would imply short recoil strokes and side loading chambers so as not to take away from the barrel length. These design implications have implications themselves. A shorter recoil means higher recoil forces. Higher forces mean potentially higher stresses in components. All these implications are consistent with a new, high technology design, positioned vertically against the lower members of the ship's structure.
Such a system must also be compatible with the high rate-of-fire requirement of a large caliber gun such as 155 mm and the fully automated multiple-rammed concept of loading. Any required recoil, chamber, breech motions must be compatible with the loader function—most likely a rotating drum type which facilitates side loading also.

PHASE I: Explore a range of chamber, breech, recoil designs that are compatible with length constrained systems and define the scope of its operation.

PHASE II: Using the design requirements from Phase I and supplied loader design, develop a basic barrel, chamber, breech, and recoil design for a generic large caliber gun system.

PHASE III: Integrate the Phase II design with specific requirements of the entire gun system

COMMERCIAL POTENTIAL: Development of such a design has application to advancement of metallurgy for very large components, advances in production techniques, high pressure dynamic sealing techniques for the chemical industry, and high speed automation and operation for large components. A particular large-market application is active crash protection in vehicles.

REFERENCES: *VGAS—Vertical Guns for Advanced Ships,* FY98 Advanced Technology Demonstration Proposal. (Available from NAVSEA PMS 429D, Mr. David L. Liese)

N96-269 TITLE: Very Low Structure Borne Noise Unit Enclosure for COTS Modules

OBJECTIVE: Develop a unit enclosure with very low structure borne noise (SBN) characteristics that provides adequate cooling and supports installation of COTS (Commercial Off The Shelf) modules in the submarine hard deck sphere mounting environment where shock isolation and very stringent low level structure borne noise levels are required.

DESCRIPTION: COTS modules are used in today's military systems as a rule rather than an exception. Overall, designing a unit structure to package these types of modules in an isolated deck environment is not a challenge because of the relaxed environmental specification, especially the structure borne noise requirement. In the hard deck environment, the structure borne noise requirement typically is just a few dBs above the ambient noise level. This is a very hard specification to meet if the COTS modules are the air cooled type because fans are needed to force air circulation within the enclosure. Fans generate spikes in the structure borne noise spectrum that are very hard to suppress. The use of conduction cool COTS modules is a solution but negates the low costs and technology refreshment associated with COTS air cooled cards. Conduction cooling is not a best value answer because this type of module is not widely accepted by the commercial industry, and the cost of the module is significantly higher and is not typically updated as technology advances.

The solution calls for innovative ways to suppress the large noise spikes generated by the fans. There are various

approaches to be considered, one way would be to lower the fan speed required and have chill plates near the modules to facilitate cooling. A second method would be to provide active noise cancellation to measure the frequencies of the noise spikes and then use active noise cancellation techniques to suppress the noises.

PHASE I: Perform tradeoff study different approaches to solve the very low level SBN problem. Based on lab test results and analysis, one approach will be selected for further investigation.

PHASE II: Design and build a prototype of the enclosure. Perform environmental testing on the design.

PHASE III: Design and build the production enclosure. Integrate the design into the military programs.

COMMERCIAL POTENTIAL: Sound abatement technologies for equipments that cohabited with humans in their relative work space will afford the practical use of such machines. More efficient methods proposed under this SBIR Topic may offer the commercial industry an opportunity to reduce costs or dimensional volume associated with sound isolation technology.-

N96-270 TITLE: Generic Electronic Card Chassis & Power Supply Enclosure

OBJECTIVE: Develop a low cost, reliable common card enclosure to support new COTS electronic card formats across multiple platforms

DESCRIPTION: The current adoption of using COTS VME card technology in military applications is most cost effective when selection of vendors commercial products are made without any modifications for ruggedization or conduction cooling to the electronics. Since most vendors products are designed for forced air cooling in laboratory environments there are several factors required to permit usage in naval ship borne environments. The most important factors are listed below:

A.) Develop a cooling approach to provide adequate cooling for a maximum population of twenty one (21) cards per chassis that also limits the structure borne and airborne noise levels to requirements imposed on naval ship borne systems.

B.) The cooling approach should be modular such that is easily reconfigured to support either a forced air cooling environment such as found on surface ships or a water cooled environment as found on a submarine platform.

C.) The Power Supply approach used to power the card cage should be highly reliable since access to the supplies will typically be limited in a ship borne environment. The Power design also must consider various electromagnetic interference and input power requirements imposed on naval ship borne systems. The approach to solve this problem would be to compile a list of all desired requirements for the candidate chassis and to develop a plug-n-play modular design that would allow maximum selection of COTS products (chassis, power supplies and cooling devices, etc.) to build the desired chassis to fit the environment. The Chassis could be used in various configurations such as a standard 6 Ft Rack, a standalone single chassis enclosure or a multi-chassis enclosure such as being proposed for the SIE enclosure on NSSN. The power and cooling design should be adequate to support a fully populated 21 slot chassis.

PHASE I: Generate a requirements matrix that cross references all desired mechanical, electrical and environmental requirements for various naval ship borne environments. Develop a conceptual design of a candidate chassis that is modular and can be used to meet these requirements by minimal reconfiguration. Compile a list of COTS vendor components and candidate suppliers.

PHASE II: Complete design and build of a prototype chassis and perform environmental qualification testing of the prototype chassis.

PHASE III: Provide complete documentation including chassis and power specification and drawings adequate to allow contractors to select desired chassis design, procure necessary components and integrate the chassis into the intended system with minimal cost and schedule.

COMMERCIAL POTENTIAL: The ability to use commercial grade electronic circuit cards in hostile environments provides industry with the opportunity to apply COTS technologies to on board shipping, aviation, and other transport applications.

N96-271 TITLE: Core Based ASIC Signal Processor

OBJECTIVE: Design and develop an ultra high performance low cost core-based ASIC signal processor to meet the Navy's future processing requirements. The goal is to develop an 8 mm .5 micron chip with the performance in excess of one billion operations per second. This goal shall be to develop a high performance signal processing chip dissipating less than five watts and very low development cost.

DESCRIPTION: The advances in VHSIC technology have reached the point where Digital Signal Processing (DSP) chips can be used to perform many intense signal processing tasks such as beamforming and sensor processing which traditionally required custom hardware. The advantages of this type of system are low N.E. cost, COTS based DSP processors, and support of industry standard software. Due to the inefficiency of most commercially developed general purpose DSPs, such systems tend to have high recurring cost and utilize significant space and power. A solution is needed that has the advantages of COTS DSP but none of its drawbacks. The emerging core-based ASIC technology provides a potentially best value solution for the Navy's future signal processing requirements. The DSP coreis a COTS design of third party vendors and can be used by numerous companies. A core-based ASIC design will be very efficient since it can be modified to meet the specific needs of individual systems and applications. Furthermore, the N.E. to develop the ASIC is low because the majority of the design is done by the core vendor. The footprint of the system can be reduced further by integrating multiple DSP cores into a single chip.

PHASE I: Survey and evaluate all commercially available ASIC core designs. The core designs will be evaluated based on the applicability of the designs to the Navy's signal processing requirements, cost vs performance, manufacturability, portability, and acceptance of the designs by the industry. At the end of the Phase I study, a single ASIC core design will be selected for further testing.

PHASE II: Obtain evaluation chips from the vendor and perform functional tests to verify the performance and applicability of this design to Navy's signal processing requirements. Evaluate the manufacturability of this design and also negotiate licensing agreements with the vendor.

PHASE III: Design and test the core-based signal processor ASIC chip. Demonstrate the applicability of this chip to the Navy's signal processing requirements.

COMMERCIAL POTENTIAL: Core based ASIC designs for signal processing may provide low cost solutions for industry applications in radar, sonogram, CT scan, MRI and numerous other measurement and analysis systems.

N96-272 TITLE: Expanded Data Link Throughput for Submarines

OBJECTIVE: Improve Submarine radio frequency data communications rates, accuracy and bandwidth requirements.

DESCRIPTION: Submarines have a need to be able to support communications with the rest of the Fleet. However, due to shipboard constraints, the antennae available require significant time at the surface to receive and transmit the growing volume of communication traffic. Solutions which can increase data throughput, minimize time on the surface and retain the data integrity are solicited.

PHASE I: Explore concepts which can solve the problem. Validate the concept through modeling and analysis.

PHASE II: Demonstrate the concept works using a prototype system in a laboratory or at sea.

PHASE III: Dependent upon the concept selected and successfully demonstrated, it is contemplated the contractor may either produce the product or assist the Navy as a Technical Agent in engineering the concept into larger systems or into existing systems.

COMMERCIAL POTENTIAL: The increasing volume of information being passed by the communications industry shows no signs of stopping. The need to get information transferred rapidly to remote sites is analogous to the submarine problem. More efficient methods proposed and validated under this SBIR Topic may offer the commercial industry an opportunity to reduce costs or transfer more information at the same cost.

N96-273 TITLE: Interactive Acoustic Analysis Processor

OBJECTIVE: Improved operator tools to guide and facilitate automated recognition of complex acoustic signatures in complex environments

DESCRIPTION: Many recent attempts to automatically recognize complex acoustic signatures have worked fairly well in controlled simulations but failed in realistic environments. Many of the failures can be explained with even casual human intervention. For example, the presence of an interfering signal or the effects of multi-path distortion which are readily recognized by experienced operators often confuse neural networks and other classifiers. The human auditory system is capable of many feats unmatched by neural networks, expert systems, or pattern recognition technology. In particular, experienced sonar operators can recognize subtle distinctions which seem to be otherwise indistinguishable, while they also recognize vastly different sounds as being from the same source. Consequently, tools which allow an operator to visually and aurally inspect data;

and to interactively guide automated classification algorithms in creating artificial hypotheses concerning the partitioning and generation of composite acoustic data sources, are valuable in developing the signal analysis.

PHASE I: Identify modifications to existing analysis systems required, if any, to allow interaction with both trained and untrained operators. Develop an organized test procedure for system evaluation and demonstrate it using limited data recordings.

PHASE II: Implement critical components of the system into a prototype and quantify their performance using both trained and untrained operators.

PHASE III: Integrate system into an existing Tactical or Support Combat System.

COMMERCIAL POTENTIAL: The need for human interaction to recognize, inspect and classify automated acoustic data can readily be translated into failure prediction, detection, and analysis of mechanical systems in commercial industries as well as marine animal and aviary research venues.

N96-274 TITLE: Signal Processing Platform-Independent Code Generation from Software Specifications

OBJECTIVE: Migration of hardware and software functions from legacy architecture sonar signal processors to modern DSP (COTS) architectures.

DESCRIPTION: A wealth of modern Sonar algorithms are currently implemented on old technology, expensive-to-maintain, digital signal processor (DSP) architectures. End-of-life issues and other logistic problems often force low-productivity development efforts on these legacy architectures. Eventually, it is life-cycle cost effective to "Migrate" the algorithms to modern DSP architectures that are available via Commercial-off-the-shelf (COTS) technology.

Even though the performance increases in the recent DSP modules and the corresponding extensive common library routines available for signal processing application provide the means to design, implement, and test software with a high productivity relative to legacy systems, the cost of this legacy-to-COTS migration effort is still considerably high. The design, code, and test portion of DSP algorithm migration should not require repetition of traditional methods, but should be able to take advantage of the preliminary phases of legacy software development of these same algorithms that were successfully completed.

Because DSP algorithm software requirement specifications closely match the actual code design, and resulting modular code implementation, it is possible to use automated code generation tools to translate the modular software requirements specification for signal processing algorithms into code design, which can then be then compiled and linked into existing DSP architectures.

PHASE I: Identify several signal processing strings that could be candidates for migration to a COTS based processing architecture. Prototype a single string on an automated signal processing code generation tool to prove that the requirements can be converted to design and implemented in a non-real time emulation system. Project productivity and resource requirements for the automated development of the prototype string.

PHASE II: Expand the prototype effort for the single string from Phase I to generate the code necessary to implement the string in real-time on a COTS DSP architecture. Generate all processing excitation data necessary to verify that the implementation meets the intended requirements. Perform detailed performance testing on the signal processing string to formally certify that it performs well enough to be implemented on a tactical platform.

PHASE III: Migrate Sonar digital processing algorithms in a full system development effort. Produce all test verification data and excitation required for formal certification.

COMMERCIAL POTENTIAL: The use of new tools and techniques to automatically generate software code from software specifications has potential application and cost-savings for all commercial marine and aircraft industries as well as entertainment industries such as audio and stereophonic businesses.

N96-275 TITLE: Mine Localization and Registration

OBJECTIVE: Mine threat database to support Submarine Combat System detection and logging and access to mine threat information.

DESCRIPTION: Mine detection sensors on board the SSN platform are designed to detect the presence of mines for the purpose of avoidance during transit through mined regions. In the course of detection, mine threats are implicitly localized. The logging

and archiving of threat locations would be very useful in situations where rapid ingress and egress is needed. It has become necessary to link the mine detection subsystem into a database that is readily accessible to the combat system for future reference.

PHASE I: Perform the conceptual design and select a suitable sensor for concept validation.

PHASE II: Implement a scaled down prototype and do limited testing in the laboratory. Develop plan for a full prototype to be tested at sea.

PHASE III: Complete and test full prototype implementation and provide plan and documentation for ultimate incorporation in an operational platform.

COMMERCIAL POTENTIAL: This topic has potential commercial application in the areas of underwater search and rescue, marine mapping and research, undersea telecommunications and off-shore oil drilling activities.

N96-276 TITLE: Plastic/Elastomeric Sensor Outer Heads/Housings

OBJECTIVE: The objective of this work is to initiate and investigate the use of castable structural polyurethanes for the manufacture of sensor outer heads/housings planned for advanced submarine (NSSN) systems such as the Photonics Mast and Integrated ESM Mast.

DESCRIPTION: The problem to be solved is the structural design and manufacture of low-cost sensor outer head/housings for advanced systems preferably using high structural performance castable polyurethane materials.

PHASE I: Based on GFI the contractor will 1) Prepare a structural design methodology for government review and approval; 2) With government approval, conduct a structural analysis based on GFI configuration data; 3) Conduct uniaxial load tensile tests of selected plastic/elastomer materials to validate structural/mechanical property data used in structural analysis; 4) Prepare a detailed, step-by-step, methodical breakdown and contextual DESCRIPTION of the approach to be used to manufacture a sensor outer head/housing in accordance with the provided GFI and items 1, 2 and 3 above.

PHASE II: Based on GFI the contractor will update Phase I results and prepare to initiate an engineering/development effort to manufacture at least two specimens each of three different outer head/housing configurations. The contractor is expected to provide manufacturing drawings for all parts to be manufactured as well as all tooling and other hardware to complete manufacture. Upon government approval of the contractor's approach and documentation, the contractor will execute the manufacturing effort mentioned previously.

PHASE III: The contractor will produce a series of production version of selected outer head/housing using castable structural polyurethane material, GFI and the technology and documentation produced in Phase I and II.

COMMERCIAL POTENTIAL: Improve access by plastics industry to Submarine market while obtaining performance and cost benefits. Aircraft, automobile, marine and chemical industries would benefit from the improved technology and larger industry capacity and revenue.

N96-277 TITLE: Advanced Spatial Filtering

OBJECTIVE: Design and develop an open architecture very high bandwidth integrated sonar signal distribution system for application aboard submarines.

DESCRIPTION: A problem encountered in the integration of acoustic systems with multiple sensor arrays is the ability to gracefully increase the bandwidth of the network interconnecting the respective processing engines. The combination of high performance chip technology and the increasingly high performance COTS technology are limited, in the scope of the task that they can support, by the inability to effectively connect the respective processors with adequate bandwidth to meet the demand of the application.

The contemporary sonar applications that are designed to address the difficult littoral environment must rely upon multiple arrays in order to support a wide variety of needs associated with littoral operation. For example, arrays with very high bandwidth demands create a very high load on the sensor signal distribution system while other lower bandwidth arrays do not.

In order to achieve the most cost effective realization of the acoustic front end it is necessary to implement an integrated signal distribution system. However, such a system must not only support very high bandwidth signal distribution but must be a truly open architecture system in order to permit future system growth and evolutionary development.

PHASE I: Evaluate a representative system, and assess the total system bandwidth necessary, taking into account

potential growth features and the open architecture requirement. Perform the conceptual design of a 'generic' front-end. Identify components and equipment necessary to implement the improved bandwidth and open architecture, and develop list of parts to be procured.

PHASE II: Implement the design of Phase I in a scaled down prototype, and develop preliminary design for full prototype implementation.

PHASE III: Complete and test full prototype implementation and provide plan and documentation for ultimate incorporation in an operational platform.

COMMERCIAL POTENTIAL: Commercial industries that would benefit from this research topic include undersea telecommunications, commercial radars (marine and land-based), undersea acoustics research and oil industry exploration.

N96-278 TITLE: Technology Infusion Methodology for COTS-based Systems

OBJECTIVE: Define and develop ground rules, along with accompanying metrics and benchmarks, for the design and development of COTS-based embedded systems. The rules and metrics will facilitate the infusion of module level technology for upgrade and cost reduction purposes.

DESCRIPTION: The shift by the military from full-Mil developments to Commercial-Off-The-Shelf approaches using best commercial practices (i.e., ISO9000) and COTS products has resulted in a need to leverage the commercial market's investment in development. Along with the gains of decreased cycle time and cost reduction, comes a dependency on fast moving, uncontrollable benefactors. Effort is required to ensure that design and development practices employed in previous Mil systems are migrating to best exploit this area. Military practices of requiring high percentages of Performance Monitoring and Fault Localization detection and dedicated hardware and software to achieve this end conflicts with the COTS culture by defeating technology upgrades and forcing endof-life redesigns. Techniques which target other key migration parameters (i.e., software protocols, operating system linkages, integration and cycle time reductions, etc.) should be identified and a business case should be developed which defines when and where measures should be applied.-

PHASE I: Evaluate (in addition to survey) typical design and development phases and identify critical parameters. At the end of the phase I, a single design will be selected for further testing.

PHASE II: A test case employing the techniques identified in Phase I will be implemented & measured against the predictions developed in Phase I.

PHASE III: A full system design will be developed using the principles generated in the previous phases applied to it.

COMMERCIAL POTENTIAL: This SBIR topic would have potential commercial applications to any computerized hardware manufacturer which uses diagnostics (i.e. automotive and medical use equipment) as well as the general microcomputer industry.

N96-279 TITLE: Low Light Level Color Imaging with Image Processing (readvertised).-

OBJECTIVE: Improve the capabilities of low-light level color imaging using either special image intensification techniques or application specific image processing algorithms or other suitable technology.

DESCRIPTION: Color cameras have shown dramatic improvements in image quality, resolution, and dynamic range. However, very little improvement has been made in the area of image intensification. Under moderate to low light level conditions, these cameras generally perform very poorly. This poor performance has greatly limited the use of color cameras in system that operate in dusk/dawn environments. Because of the obvious advantages of color over monochrome (i.e. realism, better object recognition, ship navigation, intelligence operation, and etc.), systems with lowlight level requirements could be dramatically improved if a color camera could be used in place of the existing monochrome (visible or FLIR) camera. This imagery could then be further improved if real-time (or near real-time) application-specific image processing algorithms could be used to reconstruct the imagery and provide good color rendition from the poor raw imagery.-

PHASE I: The contractor must develop an image processing system that will provide good color rendition from imagery obtained from intensified and non-intensified color cameras. It is a goal for the contractor's image processing system to provide good color rendition of imagery in an environment where the light levels vary from 1000 lux to 1E-4 lux. The image processing system may be used to enhance imagery such that one could be able to distinguish common shipboard (military and commercial) light; i.e., red, white, green, and yellow, given typical commercial (source) luminosities taken at appropriate

ranges. It is also a goal for this processing to be accomplished in as close as possible to real-time.

PHASE II: Methodologies used to design and develop this system should include but not be limited by performance trade-off analyses of adaptive image painting and/or image contrast/color stretching of intensified and non-intensified color CCDs, or Silicon Injected Target sensors. Other more exotic designs are also encouraged. Using the chosen design, the contractor will manufacture three systems. All three systems will be provided to the government for further T&E. The contractor will provide monthly technical progress reports and a final comprehensive technical report of Phase II efforts.

PHASE III: Develop the system for use in a new or existing program.

COMMERCIAL POTENTIAL: The largest commercial application for this technology would be the camcorder market. The best low-light capability of today's commercial camcorders is about 1 LUX. This still results in snowy video under some typical video recording conditions. In addition, recording in some dusk/dawn conditions and at night is not possible. Improvements in low-light capability would greatly enhance the quality and usefulness of these commercial products. Also this could be used in the commercial shipping industry to aid in collision avoidance.

N96-280 TITLE: Integrated Fuzzy Control Systems for Missiles

OBJECTIVE: To develop the fuzzy control design methodology and algorithms for the integrated (blended) control of a missile that uses multiple, non-collocated actuators, control effectors an sensors.

DESCRIPTION: Future tactical guided missiles will require higher speed and greater maneuverability, hence they will need more sophisticated control methods. The multiple, non-collocated control effectors in current use are not utilized as effectively as possible. Conventional systems use one set of control effectors, or only use the second set if the first set saturates and cannot provide adequate control. An example is a missile that utilizes aerodynamic control surfaces (fins) and attitude control (side lateral) thrusters (references 1 and 2). Higher performance missiles must use more efficient techniques for the integration and blending of the control system assets which exist or are added. One potential approach for the efficient blending of multiple control effectors is fuzzy control. Fuzzy system theory was introduced in 1965 by Lofti Zadeh (Ref. 3) as a means for describing and controlling imprecise systems (I.e., systems that cannot be described as a definite 0 or 1 bit or as on or off). Since then, fuzzy theory has been further developed (references 4,5) and been widely applied, such as in the control of aircraft, helicopters, torpedoes (Ref. 6), automobiles, radar systems, manufacturing processes, etc.-

PHASE I: Explore the application of fuzzy logic control for the blending control of a system with multiple, non-collocated actuators, control effectors and sensors. Design an integrated control system for a generic high speed tactical missile. Show feasibility through simulation of its effectiveness in intercepting missile/aircraft targets.

PHASE II: Develop on advanced control system for a Navy missile. This will include development of the control algorithm, a detailed nonlinear six degree-of-freedom simulation of the missile, and an analysis of performance in comparison with existing methods.

PHASE III: Design, build and transition an advanced control system to an Advanced Technology Demonstration (ATD) or to a planned product improvement of the STANDARD Missile 2 block IV.

COMMERCIAL POTENTIAL: The aerospace industry with applications in aircraft, satellites, missiles and the space station would benefit. Also, the research and methodology developed could be applied to other systems requiring multiple control devices and sensors.

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N96-281 TITLE: A High Doppler IR Target

OBJECTIVE: Develop innovative technology to provide calibration sources for Ship Self Defense.

DESCRIPTION: The Navy is placing an increased emphasis on systems to detect sophisticated anti-ship weapons. A cost effective means of designing, developing, testing and analyzing the performance of new detection systems requires the development of a low cost high doppler IR target. Due to the inherent complexities of the detection systems they are testing, it is extremely important that the target source produce accurate indications. Innovative techniques are required that provide the user a measure of accuracy for the results of these complex tests.

PHASE I: Conduct an analytic feasibility study, propose a system design, implementation approach and a demonstration plan.

PHASE II: Accomplish system design, develop the prototype technology and demonstrate the proposed technology as part of the PEO TAD Ship Self Defense infrastructure.

PHASE III: Transition to ongoing and planned PEO TAD, and DOD test ranges.

COMMERCIAL POTENTIAL: Advanced detection systems are not unique to the DOD. The aerospace industry is just one example of where advanced IR and doppler technologies are used heavily in the design and development of products. This new technology would be directly transferable to any industry using IR and doppler signatures to track objects.

N96-282 TITLE: Electronic Support (ES)-Radar Track Correlation

OBJECTIVE: Define and develop robust algorithms for combining tracks produced by passive electronic support (ES) receivers with those of other onboard and offboard ship sensors. Use the information measured or associated with a track by the ES system to improve track correlation, and thus permit data from other sensors concerning correlated tracks to be shared with the ES system. The algorithm should support incremental correlation, since additional and more accurate sensor data concerning a track will arrive over time. The goal is high probability of correct association (along with low probability of false association) against anti-ship missiles using typical current 2-D radar(s) and the AN/SLQ-32A ES. The algorithm must be applicable to the complete range of existing ship sensor suites and light to heavy target environments, as well as to near-term future systems.

DESCRIPTION: A variety of sensors exist aboard ships, each excelling in certain target aspects. Radars can detect and locate a target well, but have limited identification capabilities. ES systems can classify or identify targets, but cannot localize precisely. Overall combat system effectiveness could be improved by sharing data from all sensors, but an essential precondition is reliable correlation of the sensor tracks. The traditional approach to fusing radar and ES tracks uses only bearing, and has limited utility unless the environment is sparse. What is needed is a means for better correlation of tracks by leveraging all the available radar and ES data and basing a decision on multiple parameters.

PHASE I: Identify and analyze potential correlation algorithms within a current, moderate capability shipboard combat system. These would use the capabilities, and reflect the inherent performance and accuracy, of the ES and radar systems to measure parameters about the targets. In addition, the algorithm can use suitable estimated values that the ES system can assign as part of the DECM/Decoy Integration (DDI) effort, such as range and velocity, to help correlate the tracks. Perform, and report on, limited simulation and analysis to show proof of concept.

PHASE II: Support more detailed investigations of and refinements to the correlation algorithms. These may take advantage of expected sensor enhancements (such as AIEWS Phase I and AN/SPY-1D) and more extensive combat system integration. Design and participate in a realistic testbed implementation, to demonstrate the algorithm fully. The Phase II report will document all analysis and results, any special software documentation, and high-level software source code. Propose and investigate enhancements to ES and radar processing, if needed to increase the range of applicability and robustness of the correlation algorithms.

PHASE III: Further extend the algorithms to take advantage of AIEWS Phase II and similar expected improvements. Prepare specifications to guide development of operational software implementing the algorithms. Determine preferred location(s) of the correlation software. Participate in algorithm implementation and test.

COMMERCIAL POTENTIAL: There is potential applicability to air traffic control, especially to the tracking of aircraft while on the ground or in the takeoff/landing phases, where radio communications are intense and radar coverage is sometimes incomplete.

N96-283 TITLE: Thin Cell Thermal Battery

OBJECTIVE: Improve the energy density of thermal batteries.

DESCRIPTION: Present manufacturing techniques for thermal batteries involve the use of pressed powders to form anode, cathode and electrolyte 'pellets'. This technique places inherent limits on the minimum thickness obtainable due to the fragility of the pellets. This limit translates into limitations on the form-factor of the overall battery. If alternative techniques for forming the anode, cathode and electrolyte could be developed which overcome the thickness limitation then smaller batteries could be manufactured.

PHASE I: Explore alternative methods for formation of thermal battery anode, cathode and/or electrolyte utilizing existing electrochemical couples.

PHASE II: Produce thermal battery cells and batteries using method(s) selected in Phase I for evaluation against existing technology for physical size, energy density, activation time, current density, safety, etc.

PHASE III: Development of battery meeting requirements of existing weapon system.

COMMERCIAL POTENTIAL: This technology would have application to the commercial sector in areas concerned with emergency power such as for aircraft, emergency evacuation equipments, etc. Where high power is required for a short period of time.

REFERENCES: Linden, David, "Handbook of Batteries and Fuel Cells" 2ed

N96-284 TITLE: Advanced Hot Gas Valve and Manifold Technologies for Shipboard Missiles

OBJECTIVE: To demonstrate advanced high temperature (3500F) valve concepts, materials and fabrication technologies. Emphasis will be placed on the following characteristics: high temperature survival (I.e. Exposure to 3500F exhaust gases) for long duration (100 seconds), reduced weight while maintaining thermal/structural durability, innovative/low cost material processing and costing technologies, ability to provide precision control, fast response valve concepts, and ability to operate in oxidizing environments of elevated temperatures. This SBIR pertains to valves, valve bodies and hot gas manifolds.

DESCRIPTION: Demonstrated advanced high temperature valve concepts as follows:

PHASE I: Conduct critical experiments to demonstrate that selected valve component, material, or manufacturing approach meets the objectives of the SBIR topic. Testing can be conducted on nonoptional technology demonstration hardware, such as subscale of benchweight components, material test coupons, or static valve assemblies. High temperature static testing of materials or cold gas testing of moving valve components are example tests. Phase I represents technology proof-of-principle experiments - i.e., technology has good potential of meeting objectives.-

PHASE II: Identify and define specific requirements for valve technology end item use (e.g., thrust level, duty cycle, etc.). Scale desired propulsion system or component technology to desired size, weight or operating level. Demonstrate component operation under intended high temperature gas environment and with representative operational duty cycles and mass flows. Design and conduct critical experiments to demonstrate that the technology selected can meet performance, weight, cost and/or operational goals when tested if the scale proposed for end use.

PHASE III: Once demonstrated, the technology will be applicable to supporting Navy ATD programs, BMDO core technology efforts and future Area and Theater-wide TBMD programs.

COMMERCIAL POTENTIAL: The technology proposed in this SBIR topic has application to commercial space launch vehicle and satellite propulsion control systems.

N96-285 TITLE: Smart Sensor Technology for Sonar Systems

OBJECTIVE: Develop improvements and enhancements to sonar system sensors and associated signal processing.

DESCRIPTION: Innovative approaches for the design, development and implementation of integrated sonar sensors and associated signal conditioning electronics are required in response to changing operational needs and costs. This topic solicits development of smart sonar sensor technologies which emphasize low per-channel cost, high reliability, high performance and commonality across multiple applications, including towed, deployed, expendable and hull mounted sonar arrays. Requirements

for enhancement to technologies for sonar systems include: performance optimization of the combination of the sensor and signal acquisition electronics; improvement in the sonar signal to electronic noise ratio, particularly at frequencies up to 100 kHz; improvement in long term reliability, particularly for hull-mounted, embedded sensor systems where the system cannot be maintained for periods of 5 years or more; and development of programmable, adaptable sonar sensors (i.e. common hardware components) that can be used on a variety of platforms. Sensed acoustic parameters can include sound pressure level, particle displacement, velocity, and acceleration. Other measured parameters can include magnetic heading, pressure, and temperature. Desirable characteristics of smart sonar sensor systems include: high signal to noise ratio; high dynamic range; the ability to form extended sensors in one or two dimensions for the rejection of turbulent noise; high reliability with redundant sensors, electronics, and wiring; and low unit production cost. Innovative combinations of sensors and electronics are sought which can include analog signal conditioning, analog-to-digital conversion, and bi-directional digital communication over standard data links. A new government design for monolithic analog signal conditioning (MASC) of a sensor output prior to A/D conversion has been implemented as a custom integrated circuit. MASCs will be furnished upon request to offerers to whom contracts are awarded. The government will consider altering the MASC design in order to optimize it for various applications. In addition, the government will consider a joint development effort wherein the MASC is included on the same integrated circuit with the offerers circuitry such as an analog-to-digital converter.

PHASE I: Develop sufficient data to demonstrate feasibility of the proposed sensor-signal conditioner. Provide a preliminary design for the proposed sensor-signal conditioner.

PHASE II: Fabrication and performance demonstration of the prototype sensor-signal conditioner.

PHASE III: Transition fully developed products and technologies to applicable sonar programs.

COMMERCIAL POTENTIAL: The results of this SBIR will be applicable to commercial technologies such as oil exploration, underwater inspection services, process control, and medical acoustic imaging.

REFERENCES: "MASC Functional and Physical DESCRIPTION, Rev. A," Naval Undersea Warfare Center Division, Newport Technical Memorandum, TM 951128.

N96-286 TITLE: Innovative Broadband Transducer Technologies

OBJECTIVE: Develop innovative, compact, lightweight, broadband transducers for use as acoustic sources on Navy surface combatants in littoral environments.

DESCRIPTION: Current active sonar systems require increased performance to support new mission areas in the shallow waters of coastal environments. Broadband (approximately two octaves), lightweight sources currently under development promise major improvements to surface ship sonar systems. This topic addresses the next goal: development of active acoustic sources that provide the ability to transmit broadband signals substantially in excess of two octaves.

PHASE I: Based on research into state of the art, develop an initial design for an active acoustic source able to transmit broadband signals substantially in excess of two octaves. Breadboard feasibility demonstration. Justify potential of design in terms of performance enhancements.

PHASE II: Design, fabricate and demonstrate a prototype broadband source to evaluate source level, bandwidth, energy density, coupling coefficient, performance, etc., using Government furnished support assets as available.

PHASE III: Transition the source into an advanced development sonar system designed for surface combatants.

COMMERCIAL POTENTIAL: Applications of broadband source technology exist in: geophysical areas (for example, offshore petroleum exploration); underwater environmental assessment (for example, detection of dumped waste containers); and enhancement of underwater speech communication (for example, for divers involved in salvage work).

N96-287 TITLE: Passive Processing Technology

OBJECTIVE: Develop algorithms for tactical passive broadband processing.

DESCRIPTION: Innovative signal processing algorithms are required in response to changing operational requirements. Algorithm development is sought to handle the passive processing problem. Potential problems the algorithms solve may include but are not limited to: passive broadband; beamforming; full spectrum processing; trackers; data fusion; clutter reduction; acoustic contact correlation; detection; classification; and localization. Algorithms may function in real-time or non-real time,

and may address one area of the passive processing problem or many.

PHASE I: Develop mathematics of algorithm. Provide full DESCRIPTION of processing algorithm and plans for demonstration. Provide performance on simulated data that supports the theory.

PHASE II: Implementation and demonstration of algorithm using Navy provided data.

PHASE III: Products and technologies of this SBIR will be evaluated for applicability to passive processing programs.

COMMERCIAL POTENTIAL: Commercial potential for algorithms developed under this SBIR are dependent on specific problem addressed but may include: oil exploration, underwater inspection services, and medical imaging technology.

N96-288 TITLE: Improved Undersea Towing Cable

OBJECTIVE: Develop and test the application of a new synthetic material to an undersea towing cable with the capability to continuously measure water column temperature.

DESCRIPTION: This topic addresses two applications of innovative technology to undersea tow cables: (a) use of a new material in cable fabrication; (b) development of temperature sensors embedded in undersea tow cables. Offerers' proposals may address either or both of these challenges. Kevlar¿ is generally used to fabricate tow cables requiring high strength and low weight. Recently, Dow Chemical developed a new synthetic material, poly(p-phenylene benzobisoxazole) (PBO). PBO, with higher strength and lower stretch properties than Kevlar¿ at the same weight, could significantly improve cables used to tow Navy sonar systems. Potential improvements include: reduced diameters resulting in smaller handling systems; lower weight for equivalent strength for improved performance in shallow water areas; improved protection of elongation-sensitive components such as optical fibers. Temperature sensing of the water column is important for maintaining optimum sonar performance, especially in the shallow water environment. Replacing currently used expendable bathythermographs with sensors, such as microelectronic thermistors, embedded in the tow cable jacket would permit continuous temperature monitoring while operating a towed or tethered sonar array.

Phase I: Develop sufficient data to demonstrate the feasibility of: fabricating tow cable using PBO and/or providing tow cables with temperature sensing capability. Data should include affordability issues. Breadboard and test the product(s) proposed. Provide sufficient design(s) of proposed product(s) to allow for an informed decision on requesting a Phase II proposal.

Phase II: Fabricate and test prototype of product(s).

Phase III: Transition prototype into production system for Navy and/or civilian markets.

COMMERCIAL POTENTIAL: An improved strength for weight. lower stretch tow cable has use in any applications involving cables, tethers, or ropes containing synthetic material, including: oil exploration, remotely operated underwater vehicles, radar balloons, hoisting and rigging. Temperature sensors embedded in an towed or tethered system would benefit various applications such as oil exploration and environmental monitoring, including power plant discharge and biological research.

REFERENCES:

1. "Super Fiber for the Next Century, PBO Fiber," sales brochure from TOYOBA Company.
2. Debell, Timothy S, "Feasibility Study for a Tow Cable Temperature Profiler," (unpublished), Naval Undersea Warfare Center Detachment, New London, CT. August, 1995.

N96-289 TITLE: Affordable, Low Energy, Nanoscale Transistorless Static RAM

OBJECTIVE: This work seeks new approaches to memory for computers and digital signal processing wherein access speed is faster than current SRAMs, size is smaller than current DRAMs, readout is non-destructive, and refresh is not required so as to significantly drive down manufacturing cost and energy and cooling requirements for satellite and avionic applications.

DESCRIPTION: Current DRAMS are vulnerable to radiation, require a minimum of 3 clock cycles to read or write and require both a transistor and a capacitor. Current SRAMs are much faster than DRAMS, but require seven transistor and 3 times the area. Energy to refresh DRAMS is excessive for many DoD applications. Simple new, non-linear device concepts have recently appeared wherein memory latching can be obtained at ultra low power dissipation and readout "on-off" ratios of up to 10,000 have been demonstrated.

PHASE I: Investigate and further develop non-linear device concepts and materials sufficient to demonstrate a 16 bit

transistorless static random access memory (TSRAM) wherein no refresh is required and readout is non-destructive.

PHASE II: Investigate and further develop non-linear memory concepts sufficient to demonstrate a 1 kByte TSRAM wherein no refresh is required, readout is non-destructive, and access time is no greater than 1 nanosecond.

PHASE III: Develop a 64 bit wide (word wide) 1 Mbit or greater version of PHASE II above and addressable from 0 to 16,384 or greater wherein quiescent standby power dissipation density is no greater than 1 watt/cm^2. Demonstrate 10^{14} read-write operations without failure.

COMMERCIAL POTENTIAL: This is expected to lead to microprocessor chips wherein 16 MByte or greater word-wide memories are an integral part of the CPU and power dissipation of computers with large memories is less than half the current state of the art. This memory concept provides for viable USA re-entry into a field currently dominated by foreign competition.

REFERENCES:

1. H. Kroger and H. A. R. Wegener, "Steady-state characteristics of two terminal inversion-controlled switches," Solid-State Electronics, vol. 21, pp. 643-665, 1978.
2. J. G. Simmons and A. A. El-Badry, "Switching phenomena in metal-insulator-n/p+ structures: theory, experiment and applications," Radio and Electronic Engineer, vol. 48, pp. 215-226, May 1978.
3. H. Nambu, K. Kanetani, Y. Idei, N. Homma, K. Yamaguchi, T. Hiramoto, N. Tamba, M. Odaka, K. Watanabe, T. Ikeda, K. Ohhata, and Y. Sakurai, "High-speed sensing techniques for ultrahigh-speed SRAMs" , IEEE J. Solid-State Circuits, vol. 27, pp 632-664, Apr. 1992.
4. K. Itoh, "Trends in megabit DRAM circuit design" IEEE J. Solid-State Circuits, vol. 25, pp. 778-789, June 1990.

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY
Submission of Proposals

DARPA's charter is to help maintain U.S. technological superiority over, and to prevent technological surprise by, its potential adversaries. Thus, the DARPA goal is to pursue as many highly imaginative and innovative research ideas and concepts with potential military and dual-use applicability as the budget and other factors will allow.

DARPA has identified 40 technical topics, numbered **DARPA SB962-045** through **DARPA SB962-084**, to which small businesses may respond in the second fiscal year (FY) 96 solicitation (96.2). Please note that these topics are UNCLASSIFIED and only UNCLASSIFIED proposals will be entertained. These are the only topics for which proposals will be accepted at this time. A list of the topics currently eligible for proposal submission is included, followed by full topic descriptions. The topics originated from DARPA technical offices.

DARPA Phase I awards are limited to **$99,000**. DARPA Phase II proposals must be invited by the respective Phase I technical monitor. Phase II proposals are encouraged at the amount of $375,000 with additional funding available for optional tasks. The entire Phase II effort should not exceed $750,000.

The responsibility for implementing DARPA's SBIR Program rests with the Office of Administration and Small Business (OASB). The DARPA SBIR Program Manager is Ms. Connie Jacobs. DARPA invites the small business community to send proposals directly to DARPA at the following address:

DARPA/OASB/SBIR
Attention: Ms. Connie Jacobs
3701 North Fairfax Drive
Arlington, VA 22203-1714
(703) 696-2448
Home Page http://www.darpa.mil

The proposals will be processed by DARPA OASB and distributed to the appropriate technical office for evaluation and action.

DARPA selects proposals for funding based upon technical merit and the evaluation criteria contained in this solicitation document. As funding is limited, DARPA reserves the right to select and fund only those proposals considered to be superior in overall technical quality and highly relevant to the DARPA mission. As a result, DARPA may fund more than one proposal in a specific topic area if the technical quality of the proposal(s) in question is deemed superior, or it may fund no proposals in a topic area. Each proposal submitted to DARPA must have a topic number and must be responsive to only one topic.

In order to ensure an expeditious award, cost proposals will be considered to be binding for a period of 180 days from the date of closing of this solicitation. Please note that **5 copies** of each proposal must be mailed or hand-carried; DARPA will **not** accept proposal submissions by electronic facsimile (fax). A checklist has been prepared to assist small business activities in responding to DARPA topics. Please use this checklist prior to mailing or hand-carrying your proposal(s) to DARPA. Do not include the checklist with your proposal.

DARPA 1996 Phase I SBIR
Checklist

1) Proposal Format

   a. Cover Sheet - Appendix A (identify topic number) ______

   b. Project Summary - Appendix B ______

   c. Identification and Significance of Problem or Opportunity ______

   d. Phase I Technical Objectives ______

   e. Phase I Work Plan ______

   f. Related Work ______

   g. Relationship with Future Research and/or Development ______

   h. Potential Post Applications ______

   i. Key Personnel ______

   j. Facilities/Equipment ______

   k. Consultant ______

   l. Prior, Current, or Pending Support ______

   m. Cost Proposal (see Appendix C of this Solicitation) ______

   n. Prior SBIR Awards ______

2) Bindings

   a. Staple proposals in upper left-hand corner. ______

   b. **Do not** use a cover. ______

   c. **Do not** use special bindings. ______

3) Page Limitation

   a. Total for each proposal is 25 pages inclusive of cost proposal and resumes. ______

   b. Beyond the 25 page limit do not send appendices, attachments and/or additional references. ______

4) Submission Requirement for Each Proposal

   a. Original proposal, including signed **RED** Appendices A and B. (Photocopies of **RED** forms will be accepted) ______

   b. Four photocopies of original proposal, including signed Appendices A and B. ______

INDEX OF DARPA FY96.2 TOPICS

DARPA SB962-069	Lightweight Electronically Steerable Antennas
DARPA SB962-070	Micro Sensor Systems
DARPA SB962-071	Innovative Missile Warhead Kill Mechanisms
DARPA SB962-072	New Long-Range Air Target ID Techniques using RADAR
DARPA SB962-073	Selective Energy Conversion into Mechanical or Electrical Power
DARPA SB962-074	Kinematic Sensor/Sensory Environment and Multi-Axis Workstation Interface System for Synthetic Environment Operators
DARPA SB962-075	Real-Time Closed-Loop Control of Variable Geometry Fluid Mechanical Surfaces
DARPA SB962-076	Advanced Systems for Detecting and Localizing Mines or Submarines
DARPA SB962-077	Low-Cost Miniature Active Radar Frequency (RF) Package
DARPA SB962-078	High Speed Ships and Boats
DARPA SB962-079	Supporting Technologies for Uninhabited Tactical Aircraft (UTA)
DARPA SB962-080	Micro Unmanned Aerial Vehicle (UAV) System Design and Operation
DARPA SB962-081	Micro Unmanned Aerial Vehicle (MUAV) Critical Technologies
DARPA SB962-082	Modeling a Tip Vortex with Mass Injection
DARPA SB962-083	Flexible Polymeric Waveguides for Optical Display Substrates
DARPA SB962-084	Development of Novel Toners for Direct Printing of Conducting and Insulating Patterns

SUBJECT/WORD INDEX TO THE DARPA FY96.2 TOPICS

DARPA 96.2 TOPIC DESCRIPTIONS

DARPA SB962-045 TITLE: Technologies for Field Detection of Explosives Associated with Unexploded Ordnance and/or Land Mines

CATEGORY: 6.2 Exploratory Development; Sensors, Environmental Quality

OBJECTIVE: Develop and demonstrate field-deployable technologies for real- or near real-time, chemically-specific detection of explosives at concentrations (or in quantities) relevant for the detection of unexploded ordnance and/or mines.

DESCRIPTION: Most technological approaches to detect unexploded ordnance and mines attempt to exploit physical properties associated with the ordnance items or mines, i.e., differences in the optical or electric properties, or the presence of small quantities of metal. However, there has been less focus on technologies that seek to detect the explosive material directly. This is partly because chemically-specific detection of low vapor-pressure explosive compounds is difficult. While laboratory analytical techniques permit highly sensitive, chemically specific analyses, these systems are large, not real-time, and require detailed knowledge on the part of the system operator. The Federal Aviation Administration has sponsored work in explosives detection, but systems resulting from these efforts are typically geared toward large, fixed operations. Recent advances in chemically-specific sensors such as surface acoustic wave technology, nuclear quadrapole resonance, immunoassay techniques, conducting polymer-based techniques, photoacoustic cells, ion mobility, and mass spectrometry, among others, may afford new opportunities for the detection of explosives in military applications.

PHASE I: Demonstrate chemically-specific detection of explosives (vapor or condensed phase) under laboratory conditions at field-level concentrations in the presence of common environmental interferants.

PHASE II: Using a prototype system, demonstrate detection of explosives under field-conditions and evaluate the probability of detection and false alarm rate.

COMMERCIAL POTENTIAL: Local law enforcement agencies and the aviation industry have a need for assessing threats posed by explosive materials. The ability to accomplish chemically-specific explosive detection with high probabilities of detection and low false alarm rates in a portable system will expand the commercial market for these systems. Also, portable systems can be used in environmental applications to determine the presence and level of explosive contamination real-time. This enhances the efficacy of cleanup processes.

REFERENCES:
1) *A Technical Assessment of Portable Explosives Vapor Detection Devices*, NIJ Report 300-89, Marc Nyden, 1990.
2) *Hidden Killers: The Global Land Mine Crisis*, Department of State, Bureau of Political-Military Affairs, December 1994.

DARPA SB962-046 TITLE: Novel Sensor Development for Improved Process Control

CATEGORY: 6.2 Exploratory Development; Materials, Processes and Structures

OBJECTIVE: Creation of novel sensors and data analysis/fusion methodologies to enable the application of "Virtual Integrated Prototyping" (VIP) to advanced material processes.

DESCRIPTION: Research and develop innovative sensors for the monitoring and characterization of materials during processing which will generate the critical state information required as input into Intelligent Processing of Materials (IPM) models and control algorithms. Special emphasis should be on sensors or combinations of sensors which generate data related to the state of the material or component such as cure state, modulus, consolidation, dimensions, etc. Emphasis should also be on data analysis and fusion methodologies that permit critical parameters to be inferred from the measured data for cases where one cannot directly sense a parameter that the physical-chemical model indicates is critical to control of the process. Algorithmic innovation or application of recent advances in automatic target recognition, such as wavelet-based techniques for feature extraction and denoising, is of particular interest. An additional and broader application of this data will be to VIP, which refers to modeling and simulation-based prototyping of integrated process, sensing, and control systems, for industrial materials manufacturing applications critical to DoD.

PHASE I: Perform simulations or simple laboratory experiments to validate the sensor and/or data analysis/fusion methodology.

PHASE II: Create and validate the sensor and/or data analysis/fusion methodology on an application of interest to DoD. Complete documentation of test parameters and results must be delivered.

COMMERCIAL POTENTIAL: The creation of smart process control sensors will enable the more efficient development of advanced material processes of interest to DoD. As VIP becomes standard practice, these sensors will provide the underlying foundation for the control systems which will greatly reduce manufacturing costs and improve the quality of the components produced.

REFERENCES:
1) Wadley, H.N.G. and W.E. Eckhert, "Intelligent Processing of Materials for Design and Manufacturing," J. Metals 41, 10 (1989).
2) Roy, Walter N. and Sean Walsh, eds., 41st Sagamore Army Materials Research Conference (Intelligent Processing of Materials), 29 Aug - 1 Sept 1994, H.N.G. Wadley, "Intelligent Processing of High Performance Materials," pp. 57-94.
3) Laine, Andrew F. and Michael A. Unser, eds. Wavelet Applications in Signal and Image Processing II, Vol. 2303, 25-28 July, SPIE, 1994, Ronald R. Coifman and Naoki Saito, "Extraction of Features from Backgrounds."

DARPA SB962-047 TITLE: Self-Routing Optical Switching

CATEGORY: 6.2 Exploratory Development; Command, Control and Communications; Electronics (Optoelectronics)

OBJECTIVE: Promote the development of optical signal switching technology that will enable the self-routing of signals in networks of sensors and other distributed communication nodes.

DESCRIPTION: Research leading to the development of self-routed, optical switching technology that will enable communication between a base station and nodes in a network with little or no power to actuate routing is sought. Candidate technologies for achieving such routing include wavelength selective add/drop multiplexing elements with tunable laser sources, optically active switches in which the presence of signal in the access fibers activates the switching function, or the application of non-linear elements that can be sequentially activated, possible with short optical pulses. Anticipated systems applications include very large networks with more than a hundred nodes.

PHASE I: Develop proof-of-concept design either through fabrication of prototype components, or by detailed modeling of designs based on demonstrated performance of existing components.

PHASE II: Develop and demonstrate a fully functional prototype capable of demonstrating critical functionality and provide design documentation for a full scale implementation.

COMMERCIAL POTENTIAL: The development of self-routing optical switches that require little or no local powering will enable large scale networks of optically addressable sensors.

REFERENCES: OSA Proc. on Photonics in Switching, Vol 16 (1993).

DARPA SB962-048 TITLE: On-Chip Chemical Analysis

CATEGORY: 6.2 Exploratory Development; Environmental Quality, Chemical and Biological Defense, Sensors

OBJECTIVE: Develop integrated microsystems for on-chip chemical analyses.

DESCRIPTION: Components of many standard chemical processes have now been demonstrated at the level of the micromachined chip. The advantages to moving analyses on-chip include reduced sample and reagent volume requirements, reduced power requirements, the ability to perform multiple analyses simultaneously, and the ability to precisely control reaction chamber conditions. The greatest potential benefits of performing wet chemical manipulations in microfabricated environments, however, will come when multiple components and complete processes can be performed using fully integrated microsystems.

Proposers are asked to develop and prototype such integrated chemical processing microsystems. Depending on the particular application, a number of integrated microfluidic components will be required to store, transport, mix, and meter sub-microliter liquid quantities. Proposers are asked to detail current methods and instruments available to perform the proposed chemical analyses and to identify the specific advantages of performing the proposed chemical sequence at very small volumes

in an integrated microsystem approach. Preference will be given to the development of microsystems to perform reaction and analyses sequences that either cannot be performed or cannot be adequately controlled at the macroscale. The target prototype microsystem should include both components and control in a single integrated package, although monolithic integration is not a requirement.

PHASE I: Develop proof-of-concept design. Identify and analyze the major problem areas associated with the proposed technology. Produce a development plan which addresses the approach to solving key technology issues. Identify quantitative goals for system performance.

PHASE II: Develop and demonstrate a fully functional prototype capable of demonstrating critical functionality. Provide design documentation for a full scale implementation. Explore critical parameters and optimize the design. Provide in-depth performance evaluation.

COMMERCIAL POTENTIAL: This technology will have commercial application in environmental monitoring, drug discovery and development, and physiological monitoring.

REFERENCES:

1) Harrison, D. J., Glavina, P.G., and Manz, A., "Toward Miniaturized Electrophoresis and Chemical Analysis Systems on Silicon: An Alternative to Chemical Sensors," Sensors and Actuators B, Vol. 10, 1993, pp. 107-116.

2) Fettinger, J.C., Manz, A., Ludi, H., and Widmer, H. M., "Stacked Modules for Micro Flow Systems in Chemical Analysis: Concept and Studies Using an Enlarged Model," Sensors and Actuators B, Vol. 17, 1993, pp. 19-25.

3) Van den Berg, A., and Bergveld, P. (eds.), Proceedings of Micro Total Analysis Systems Conference, Twente, Netherlands, Nov. 21-22, 1994.

DARPA SB962-049 TITLE: Low-Cost, High Thermal Conductivity, Low Mass Density Electronic Packaging Materials

CATEGORY: 6.2 Exploratory Development; Electronics; Materials, Processes and Structures; Manufacturing Science and Technology

OBJECTIVE: Develop and demonstrate a low-cost, high thermal conductivity and low mass density material for use in electronic packaging. Target material characteristics are: cost less than aluminum heat sinks, thermal conductivity at least 200 W/mK, and mass density less than aluminum.

DESCRIPTION: Advances in integrated circuit manufacturing and innovations in design technologies are leading to new generations of wireless, portable information technology products. Size and weight, along with functionality, cost, and reliability are among the factors that differentiate these systems. A dual strategy of reduced power consumption and improved thermal management promises to greatly improve the performance capability of portable systems. In this project, thermal management materials are sought which perform better and cost less than those currently used in electronic products.

PHASE I: Provide a detailed technical plan that describes the specific material development approach and the anticipated material properties. Perform computer simulations, fabricate material samples, and measure material properties.

PHASE II: Implement the material development plan of Phase I. Perform extensive measurements to verify material properties. Demonstrate capabilities to produce the material at anticipated costs. Provide cost model of the material development process and transition plan for material commercialization.

COMMERCIAL POTENTIAL: Low-cost, light-weight, high thermal conductivity materials are critical to commercial electronic system OEM's. Applications such as laptop computer cases, convection cooled heat sinks for processors, and heat spreaders for wireless transmitters would benefit greatly from such a material.

DARPA SB962-050 TITLE: Advanced Collection Management

CATEGORY: 6.2 Exploratory Development; Battlefield Awareness

OBJECTIVE: Develop algorithms and software to optimize and synchronize high-priority collection by multiple manned and autonomous assets subject to platform and sensor operational constraints.

DESCRIPTION: The addition of the Tier 2+ and Tier 3- Unmanned Autonomous Vehicles (UAVs) to current intelligence, surveillance and reconnaissance assets will provide unprecedented Battlefield Awareness to theater commanders. To fully realize the potential value of these platforms, algorithms and software are required to generate coordinated, multi-platform plans that ensure coverage of high priority targets while satisfying platform track (e.g., avoidance of air defense), sensor (e.g., viewing geometry) and other constraints. This represents an extremely complex problem, combining trajectory optimization, target-track assignment, scheduling and time-line optimization. New solution methodologies are sought for this problem to provide high quality plans and to reduce the timeline for plan generation to support dynamic sensor tasking.

PHASE I: Design a comprehensive solution approach. Prototype one or more of the key algorithms to demonstrate performance improvement versus heuristic approaches.

PHASE II: Develop a Joint Collection Management Tools (JCMT) compliant, rapid prototype implementation of the solution approach.

COMMERCIAL POTENTIAL: In addition to military applications, the algorithms and software developed would have significant application to scheduling and resource allocations in the manufacturing and transportation industries.

REFERENCES: Airborne Reconnaissance Technical Architecture Program Plan, Defense Airborne Reconnaissance Office, 1995.

DARPA SB962-051 TITLE: Advanced Radio-Frequency Interference (RFI) Suppression Techniques for VHF-UHF Radar

CATEGORY: 6.2 Exploratory Development; Sensors

OBJECTIVE: Develop innovative techniques for suppressing radio frequency interference in ultra-wideband synthetic aperture radars (SAR).

DESCRIPTION: Innovative methods and applications for the temporal, spectral or spatial cancellation of RFI in ultra-wideband (UWB) SAR images are sought. RFI may consist of many narrow-band sources such as UHF and VHF television, FM radio, cellular telephones, mobile radios, or a few localized wideband sources such as jammers or other radars. Develop innovative RFI suppression techniques that provide an improvement over current technology in terms of: improving the amount of RFI suppression, minimizing the effects upon the SAR impulse response function, or reducing the processing requirements for the same or better performance. Techniques that are suitable for demonstration and test with recorded data on high performance parallel processors are encouraged.

PHASE I: Define the application, algorithm and approach to suppressing RFI in UWB SAR imagery, and quantify the expected benefits through simulation.

PHASE II: Create a full implementation of the algorithm, and validate the performance using actual UWB SAR imagery. Complete documentation of the source code, test cases, and results must be delivered.

COMMERCIAL POTENTIAL: RFI in UWB SAR imagery is a major limiting factor in SAR performance. Efficient algorithms will increase the ability to perform land use planning, hydrology studies, earthquake analyses, and target detection. These areas are predicted to be of increasing interest by federal, state and local governments in the coming years.

REFERENCES: Giglio, D. A., "Algorithms for Synthetic Aperture Radar Imagery II," Proceedings of the International Society for Optical Engineering (SPIE), Orlando, Florida, 19-21 April 1995, pp. 71-129.

DARPA SB962-052 TITLE: Agile Modeling for In-Field Modification of Domain Information, Inference, and Knowledge Bases

CATEGORY: 6.2 Exploratory Development; Modeling and Simulation

OBJECTIVE: Innovative approaches for adaptation and in-field modification of templates, models, and knowledge bases for automated target recognition (ATR), natural language processing (NLP), and fusion, correlation, and assessment.

DESCRIPTION: New methods are sought to maximize the flexibility of model-based and template-based computation supporting battlefield awareness, and to overcome the impediments to model-based information processing posed by: the large investments

needed to construct those models, the difficulty in involving the user in building and understanding those models, and the fact that those investments need to be replicated for each new application, target set, or tactical environment. Agile modeling and templating solutions are desired in order to create broadly reusable tools, rather than on onetime builds of fragile models, so that the user is the one responsible for maintaining their own picture of how the battlefield works. These methods may include learning techniques based on incoming observations as well as user-directed modifications based on evolving tactical or strategic situations. Template-based techniques would use data gathered from new targets from limited looks to build templates to support ATR algorithms. Applications should be directed toward capabilities including intuitive user interfaces, model construction and sharing based on generic ontologies or model fragment libraries, and automated updates to executable code. Techniques that exploit current leading edge technology in both knowledge-based (rules, schemata, first-order logic, etc.) and stochastic (Bayes nets, fuzzy logic, etc.) models and inference, including modeling techniques for unifying those approaches, are all encouraged.

PHASE I: Define theoretical approaches, apply concepts to limited problem sets, or explore a more generalized application of existing techniques.

PHASE II: Create a full implementation of templating, modeling, algorithmic, or user-interface techniques. Incorporate into existing model-based systems and deliver complete documentation of source code, test cases, and results.

COMMERCIAL POTENTIAL: The flexibility and reuse of domain information and knowledge bases are major limiting factors in the application of model-based information processing systems. Agile modeling techniques are predicted to have significant impact on the spread of such systems for remote sensing, language-based observation, and evidential reasoning applications, through an increase in the utility and reusability of core systems and in user access to, and control of, the adaptations made for particular applications.

REFERENCES:
1) R. Lopez de Mantaras and D. Poole, eds., Proc. Uncertainty in Artificial Intelligence, Morgan Kaufmann, San Francisco, 1994, pp. 262-69, 440-46.
2) R. Neches, et al., "Enabling technology for knowledge sharing", AI Magazine, 12(3), 1991, pp. 16-36.

DARPA SB962-053 TITLE: Simulating Human Behavior for C3I, Planning, and Battlefield Awareness

CATEGORY: 6.2 Exploratory Development; Modeling and Simulation

OBJECTIVE: Create realistic Artificial Intelligence technologies to accurately represent human decision making for simulated C3I, Planning, and Battlefield Awareness systems.

DESCRIPTION: DARPA is seeking an integrated solution to providing dominant battlefield awareness. Simulation represents one method of investigating issues relative to this comprehensive view. Current representations of human behavior in simulation are still rudimentary, based largely on finite state machines or simple rule sets. DARPA is seeking advanced technologies which will allow improved representations of human decision making on the battlefield at a reasonable computational cost. The resultant computer generated forces must run much faster than real-time and at high echelons of command (Army Brigade and above, or equivalent). In addition, the full range of appropriate staff functions to support C3I, Joint Task Force Planning, and Battlefield Awareness, such as analysis, fusion, evaluation, dissemination, decision making, and execution should be addressed. Solving this requirement is fundamental to the improvement of simulation throughout DoD.

PHASE I: Design and Execution Plan for a Prototype of Human Behavior in Computer Generated Forces.

PHASE II: Instantiation of Prototype in a Service/Intell agency specific mission area.

COMMERCIAL POTENTIAL: There is significant potential within civilian industry, particularly the entertainment industry, for the use of this technology.

REFERENCES:
1) Marshall, C. And Garrett, R. "Simulation for C4ISR: Command, Control, Communications, Computers, Intelligence, Surveillance, & Reconnaissance," Phalanx, March, 1996.
2) Hayes-Roth, B. "On Building Integrated Cognitive Agents: A Review of Allen Newell's Unified Theories of Cognition." Artificial Intelligence 59:329-341. 1993.
3) Laird, J.E.; Jones, R.M.; and Nielsen, P.E. "Coordinated Behavior of Computer Generated Forces in TacAir-Soar." In the Proceedings of the Fourth Conference on Computer-Generated Forces and Behavioral Representation, 325-332/ Orlando, Fla.: University of Central Florida Institute for Simulation and Training, 1994.

4) Nelson, G.; Lehman, J.F.; and John, B.E. "Integrating Cognitive Capabilities in a Real-Time Task." In Proceedings of the Sixteenth Annual Conference of the Cognitive Science Society. Hillsdale, N.J.: Lawrence Erlbaum. 1994.

DARPA SB962-054 TITLE: Battlefield Dynamic Databases

CATEGORY: 6.2 Exploratory Development; Modeling and Simulation

OBJECTIVE: Innovative methodologies for implementing dynamic databases based on real-world data in simulation, or based on evidential and knowledge-based reasoning.

DESCRIPTION: The extraction of appropriate information from the vast amounts of data being collected by current and next generation sensor systems should lead to a better understanding of the battlefield. Two alternative approaches promise to enable the filtering, abstraction and integration of relevant information from this sea of data:

(1) Simulation. Because battlefield simulations provide a higher level abstraction or "view" of the battlefield, simulation models should provide a means of transforming battlefield data into battlefield information in a context most relevant to the commander. Coupling a battlefield dynamic database with a large scale simulation should support higher levels of fusion as well as advanced Intelligence Preparation of the Battlefield, Battle Damage Assessment, and After Action Analysis and Review. The resultant computer generated forces must run much faster than real-time at a reasonable computational cost.

(2) Evidential and Knowledge-Based Reasoning. Detecting relevant features, objects, targets, military units, strategic movements, etc., in the vast amounts of available sensor data may benefit from a hybrid reasoning strategy which mixes probabilistic approaches to evidential reasoning, such as Bayesian inference, with more symbolic, logic-based approaches to knowledge-based reasoning. This hybrid approach could enable the use and integration of multiple reasoning strategies, at different levels of abstraction, resulting in the more accurate interpretation of sensor data at all levels of the feature-object-target-unit hierarchy.

PHASE I: Define the system approach, the limits of scalability, and quantify the expected benefits achievable through simulation or evidential and knowledge-based reasoning.

PHASE II: Create a prototype system that demonstrates the concept and evaluates either: the hypothesis that simulation view of the battlefield can be used to aid in the transformation of battlefield data into battlefield information for the commander, or the hypothesis that a hybrid evidential and knowledge-based reasoning approach could be used to interpret and transform sensor data more accurately into battlefield information for the commander. Complete documentation of experimental methodology, test cases, and results must be delivered.

COMMERCIAL POTENTIAL: The development of an efficient mechanism for using real-world information as the basis for simulations could dramatically reduce the cost of using simulations for such things as disaster preparedness, and emergency management.

REFERENCE: "Simulation Data and the Need for Standardization," Phalanx, December 1995.

DARPA SB962-055 TITLE: Rapidly Mapping Real Environment Changes to Synthetic Environments

CATEGORY: 6.2 Exploratory Development; Modeling and Simulation

OBJECTIVE: Design and implement technological approaches to rapidly create and realistically distribute terrain information.

DESCRIPTION: Mission rehearsal and intelligence preparation of the battlefield are a primary mission for both Battlefield Awareness and simulation. Accurate, current, and realistic representation of the environment digitally is challenging. Although some research is being conducted in introducing dynamic changes to the synthetic environment, of particular interest is mapping real-world environmental changes to the synthetic environments. For mission rehearsal purposes it would be extremely valuable to be able to quickly map changes, such as blown-out bridges, into the terrain database without having to recreate the database.

PHASE I: In detail, define a technical approach which will lead to a Phase II demonstration of a techniques) for solving the rapid transformation of real-world environmental data into digital representations capable of being used in a simulation environment.

PHASE II: Demonstrate a tool that embodies principle technical solutions to rapid insertion of real-world data into synthetic environments. The demonstration should focus on an implementation under the current DoD High Level Simulation

Architecture for modeling and simulation. Complete documentation of test cases and results must be delivered.

COMMERCIAL POTENTIAL: The development of computationally-efficient and cost-effective means of dynamically changing synthetic environmental representations would have broad ranging applications from emergency disaster preparedness to agricultural crop and environmental impact analysis.

REFERENCES:
1) An Introduction to the High Level Architecture (HLA) Runtime Infrastructure (RTI); Calvin, Weatherly, Mar 1996 DIS Conference paper.
2) The DoD High Level Architecture and the Next Generation of DIS; Miller, Mar 1996 DIS Conference paper.

DARPA SB962-056 TITLE: Three-Dimensional (3-D) Modeling by Videotaping

CATEGORY: 6.2 Exploratory Development; Computers and Software

OBJECTIVE: Design and demonstrate techniques to reconstruct 3-D scene and object structure from an image sequence, taken freely by an ordinary video camera.

DESCRIPTION: Automatic acquisition of 3-D models of buildings, vehicles, and structures is in high demand for visualization and mission-rehearsal systems. However, manual construction of such models takes far too long to be of practical use, and interferometric synthetic aperture radar (IFSAR) and overhead imagery are too scarce for many applications (and don't offer a complete solution).

The structure-from-motion problem has been long studied and much is known about 3-D constraints derivable from sequences of images in which point correspondences can be established. The processing power of commodity computers is now reaching the point where it may be possible to develop practical 3-D modeling applications that exploit these results. Potential military applications of this technology include: automatic construction of detailed terrain models from airborne video cameras; automatic construction of 3-D models of building exteriors and interiors from hand-held video; rapid acquisition of 3-D models of vehicles for use in visualization systems.

PHASE I: Design and prototype key components of system to be built in Phase II. Evaluate accuracy, reliability, and flexibility attainable. Finalize design of complete system.

PHASE II: Build, demonstrate, and validate complete system.

COMMERCIAL POTENTIAL: The development of computationally efficient, low-cost modeling techniques using video cameras has a ready market in such diverse applications as model capture for computer graphics and visualization of properties in real estate and construction. Potentially, the ability to rapidly produce 3-D models by videotaping could spawn a new genre of consumer products for home use.

REFERENCES: Proceedings, ARPA Image Understanding Workshop, Palm Springs, California, February 12-15, 1996. Available from: Morgan Kaufmann ($50).

DARPA SB962-057 TITLE: Next Generation Automated Target Recognition (ATR) Algorithms and Automatic Target Detection and Terrain Mapping with Foliage-Penetrating (FOPEN) Radar

CATEGORY: 6.2 Exploratory Development; Sensors

ATR OBJECTIVE: Create efficient computer algorithms to exploit higher dimension ATR attributes such as polarization, absolute intensity, and multi-kernel images to increase ATR performance.

FOPEN OBJECTIVE: Create efficient computer algorithms to detect manmade objects, and/or perform radar mapping of the terrain, below the tree canopy.

ATR DESCRIPTION: In order to meet military commanders' information needs, ATR systems must exploit available target observables. Many of today's ATR algorithms are based on a two-dimensional scene representation. By exploiting higher dimension ATR attributes, the ATR performance is improved. Some of the unexploited observables are polarization, absolute

RCS intensity, and multi-kernel images. By using the available target polarization, preferential target scattering centers provide information useful in target classification and identification. Absolute versus relative intensity is used in a similar way to exploit known target RCS values and variations. Finally, multi-kernel images provide a vector for each two-dimensional pixel that contains the various attributes used for ATR exploitation.

FOPEN DESCRIPTION: Innovative methods and applications for the problems of detection of manmade objects and radar mapping of the terrain surface under vegetation coverage are sought. Develop algorithms to automatically process and detect features using ultra-wideband (UWB) FOPEN synthetic aperture radar (SAR) imagery consistent with high throughput, parallel processors. Make use of any or all of the following: change detection, image-recognition and contextual information, polarization signature, high-resolution spatial-spectral signature, and interferometric height measurements based on the physics of microwave interaction with the foliage canopy. Techniques that are capable of dealing with incomplete or corrupted data are required.

PHASE I: Define the applications, algorithms, and approaches to exploit features using next generation ATR algorithms and UWB SAR imagery, and quantify the expected benefits through simulation.

PHASE II: Create an implementation of the algorithms, and validate the performance using actual SAR imagery. Complete documentation of the source code, test cases, and results must be delivered.

ATR COMMERCIAL POTENTIAL: The development of automated ATR applications will increase one's ability to perform many environmental and disaster relief tasks not currently possible. This research area is of current interest by federal, state, and local governments, and the needs are expected to increase in the coming years.

FOPEN COMMERCIAL POTENTIAL: The development of efficient automated methods to detect objects under the trees and to perform sub-foliage mapping will increase the ability to perform land use planning, hydrology studies, earthquake analyses, and target detection. These areas are predicted to be of increasing interest by federal, state and local governments in the coming years.

REFERENCES:
1. Fleischman et al, "Foliage Penetration Experiment, Parts I-III," IEEE Transactions on Aerospace and Electronic Systems, January 1996, Volume 32, Number 1, pp. 134-166.
2. Giglio, D. A., "Algorithms for Synthetic Aperture Radar Imagery II," Proceedings of the International Society for Optical Engineering (SPIE), Orlando, Florida, 19-21 April 1995, Session 8, SAR Topographic Mapping, pp. 371-401.

DARPA SB962-058 TITLE: Synchronous Collaboration Glueware, Tools, and Metrics

CATEGORY: 6.2 Exploratory Development; Computing and Software

OBJECTIVE: Develop software (glueware), tools, environments that enable several or more users to simultaneously and seamlessly view, share, and update documents regardless of which hardware, operating system, or application was used to create the original document. Develop metrics and related test probes and analysis tools, benchmarks, and other measurement approaches to quantitatively and qualitatively evaluate and certify real-time videoconferencing and personal conferencing systems and services.

DESCRIPTION: Development of software (glueware), tools, environments that enable at least three users on different clients and operating systems using different commercially-available word processing, presentation authoring, and/or spreadsheet applications to see each other and rapidly interconnect these applications to simultaneously view and update a "shared" object. This "shared" object would be a multimedia-based document, presentation, or spreadsheet with a look and feel provided to each user that appears like their native application or can be toggled to provide all collaborating users with a seamless, integrated view of the shared object. For example, user A using AmiPro on a PC running Windows, user B using Microsoft Word on a Macintosh running MacOS, and user C using WordPerfect on a Sun running Solaris can synchronously collaborate on a complex word processing document embedded with pictures, graphs, and tables. This objective also includes the development of metrics and related test probes and analysis tools, benchmarks, and other measurement approaches to quantitatively and qualitatively evaluate and certify real-time videoconferencing and personal conferencing systems and services.

PHASE I: Survey commercial collaboration products and services and business function software. Select a subset of products and services to interconnect and perform synchronous collaboration and with which to focus test measurement and

analysis techniques. Define in detail an approach to achieve the objective. Prototype initial implementation and evaluate using defined criteria. Establish productization/business plan.

PHASE II: Create the full implementation of a tool/environment that embodies the Phase I software and approach. Validate performance/usability by evaluating selected commercial systems and services in a command and control, engineering design, or business office scenario. Complete documentation of test cases and results must be delivered.

COMMERCIAL POTENTIAL: Research to rapidly compose instantiations of collaboration between individuals, between people and systems, and between systems is well underway. Commercial videoconferencing and personal conferencing products and services are currently being developed and marketed. The usability of research results and commercial componentware is dependent upon its perceived and documented value. Disciplined test metrics, measurement, analysis, and certification will allow this research to prosper, accelerate bringing ideas to market, improve the quality and usefulness of collaboration products and services, and provide consumers with the ability to make informed choices. This research will accelerate the access and usability of multiple collaboration paradigms by allowing the use of legacy business function software applications. The ability to conduct synchronous collaborations between individuals consistent with their own native legacy functionality will buy down additional learning curves and more quickly empower groups to be more collaborative and productive.

DARPA SB962-059 TITLE: System Synthesis Environment

CATEGORY: 6.2 Exploratory Development; Computing and Software

OBJECTIVE: Design and develop automated and visual aids to assist systems engineers in the development of complex systems.

DESCRIPTION: The instantiation of the very complex systems being designed as a result of the push to COTS technology has very much become a "system synthesis" approach. That is, there are given technologies, COTS based, consisting of communication, input/output (I/O) as well as computational resources that must be orchestrated into a system capable of meeting a given set of requirements that often include real-time and embeddable constraints.

As a result of this system synthesis, the opportunity exists to develop an environment to support systems engineers in the definition of their system. Such an environment would be populated with a database of existing components or components being considered. It would also capture sufficient algorithmic, I/O, operating system, and behavioral information to enable the system engineer to select the various resources and design the "best" system solution in response to the given set of requirements.

The environment should be capable of performing sufficient performance analysis to enable an architecture assessment of sufficient fidelity and quality so that a determination of "goodness of fit" of the proposed synthesized system is possible. Approaches that automate as much of the process as possible and provide aids to the system engineer (modeling, heuristics, visualization, automated processing, real-time aspects, etc.) would be most attractive. The environment must be capable of representing the system at various levels of detail and supporting various views of the system. For example, not only should the environment provide a wiring diagram, but also a view of the software architecture or a parts list or sufficient information to enable a reliability analysis to be conducted. Finally, the environment should be "open" to allow for the inclusion of other tools in a "plug and play" fashion (e.g., a tool that might support a visualization of the modeled system).

PHASE I: The report delivered at the end of Phase I should clearly define the environment proposed and address the user interface that will be employed by the system engineer. The report should define how the environment will be applied in Phase II, how databases will be populated and maintained and how the environment will be validated, and discuss the "openness" of the proposed solution.

PHASE II: The proposed environment should be developed and applied to a military or commercial application. Significant test data should be gathered and reported against actually developed systems to validate the environment and assess its completeness. Plans for commercialization of the approach and availability to DoD should be developed in Phase II.

COMMERCIAL POTENTIAL: There is a growing demand for aids when confronted with the increasingly complex systems required by today's high performance demands in both the industrial and military sectors. The data base portion of the environment, if properly maintained, as well as the aids provided to the systems engineer, will enable the more rapid development of systems as well as provide mechanisms to address "what if" analysis. The increased military use of COTS, which is also shared by the industrial community, will provide for use by both markets.

REFERENCES:

1) World Wide Web DARPA/ITO Home Page, URL http://www.ito.darpa.mil

2) The High Performance Computing and Communications "Blue Book" for 1995 and 1996, URL http://www.hpcc.gov

DARPA SB962-060 TITLE: Model Neutral Data Representation

CATEGORY: 6.2 Exploratory Development; Computing and Software

OBJECTIVE: Define and develop a mechanism to enable interoperability of differing model representations.

DESCRIPTION: Modeling of systems has increasingly become the method of choice when attempting to understand, characterize, or analyze the very complex systems being built today to solve military problems.

Models that attempt to represent hardware performance, software performance, input/output, and various communication attributes (e.g., protocols, latency, throughput, etc.) in addition to thermal and reliability analysis are examples of where models with different views are being successfully incorporated. However, many of these models require common information and would benefit from the seamless capture of the information provided by another model (e.g., reliability analysis might require thermal analysis results). What is required is a data structure and access mechanisms available to each model to enable the model to obtain common information which may also be used by the model to provide data that might be utilized by other modeling views and/or methodologies.

Such a representation is a data middleware that would provide a "plug and play" capability for new models being developed as well as obviate the requirement to provide translators between all possible model views.

Successful solutions will be able to take several representations of a system—e.g. a performance model and a thermal analysis model—and enable each representation to access the canonical data structure to obtain the requisite information required by it. Visualization mechanisms that support these various views are also of interest. For example, the model neutral representation should support a discrete event simulation as well as a Petri-net simulation and provide visualization techniques consistent with the solution domain of the user.

PHASE I: The report delivered at the end of Phase I should clearly define the data structures proposed and should address the access mechanism that will provide for the seamless integration of models. The report should define how the data structures and access mechanisms will be applied in Phase II, what metrics will be used to measure the degree of interoperability, and how models will use the mechanisms. The report should also discuss the "openness" of the proposed solution.

PHASE II: Proposed data structures and mechanisms should be developed and applied to a collection of modeling methodologies to demonstrate the interoperability of the approach. For example, demonstrations using Petri-net based models, discrete event simulation, and thermal models using the data structures would be of interest. Significant test data should be gathered and reported against the metrics proposed to validate the assumptions on actual applications of interest to defense. Plans for commercialization of the approach and availability to defense should be developed in Phase II.

COMMERCIAL POTENTIAL: There is a growing demand for modeling of systems in industrial and military applications. Typically, various models need to be executed in order to extract the requisite information. The ability to share common data will significantly reduce the time required to develop and increase confidence in the models as any model assumptions are centralized. Many of the modeling techniques are common between defense applications and commercial applications and both markets wish to use the same technology base.

REFERENCES:
1) World Wide Web DARPA/ITO Home Page, URL http://www.ito.darpa.mil
2) The High Performance Computing and Communications "Blue Book" for 1995 and 1996, URL http://www.hpcc.gov

DARPA SB962-061 TITLE: Novel Approaches to Creating Fault Tolerant, Scalable, Heterogeneous Computing Systems for Defense Applications from Components Not Necessarily Designed to be Fault Tolerant

CATEGORY: 6.2 Exploratory Development; Computing and Software

OBJECTIVE: Develop and demonstrate novel approaches to creating scalable, heterogeneous, fault tolerant computing systems for defense applications comprised of components that are not necessarily designed to be fault tolerant (e.g. COTS).

DESCRIPTION: Fault tolerant embedded systems with high availability and data integrity have always been central to core DoD applications where loss of information or control can seriously damage the success of a mission. Applications include aerospace,

telecommunications and real-time command and control. The rapid increase in automation and computer control in all areas of decision-making means that traditional fault tolerant solutions based on slow or outdated technology which incur long lead times for design and validation are no longer viable. New methods that incorporate fault tolerance features from the early design stage, and include rapid error detection and recovery from the hardware, software, and application perspective—keeping in mind real-time constraints—are essential. The issues of networking of heterogeneous components and their scalability must also be addressed. Importantly, testing and validation of the system against a wide range of adverse conditions and with a high degree of confidence must be ensured.

New and novel approaches to fault tolerant computing have not been developed. Increased use of scalable, heterogeneous high performance computing systems, both parallel and distributed, consisting of general purpose processors, digital signal processors, Field Programmable Gate Arrays (FPGAs), and Application-Specific Integrated Circuits (ASICs) connected by one or more communication fabrics attached to a collection of sensors demand new and innovative approaches to fault tolerant computing.

Proposals are sought in the area of scalable, heterogeneous, fault tolerant systems in the context of a "complete system solution." In particular, what is required at the chip level, the multi-chip level, the board level and the system level in the communication, memory and storage components, as well as operating system/kernel support, to enable the transparent, robust and cost-effective development and deployment of fault tolerant systems in a scalable, heterogeneous embedded environment? Some specific issues to be addressed include: the ability to test, diagnose, and repair manufacturing and operational faults; issues of providing software and network fault tolerance; and the development of hardware and/or software environments for validation of new designs incorporating new technologies in real-time operational conditions. Solutions must address the increased use of COTS components by the military community. That is, how to build fault tolerant systems when working with components that were themselves not designed to be fault tolerant. Solutions that address the incorporation of these fault tolerant solutions into legacy systems are also of interest.

Solutions should be non-intrusive and may be hardware or software based. Because of the real-time nature of the systems, the solutions must be sensitive to low latency requirements.

Also of interest is the definition, development, evaluation, and validation of a fault tolerant measure, recognizable by the general community, that may be used to not only compare/contrast various fault tolerant implementations, but can also be used in a system specification.

PHASE I: The report delivered at the end of Phase I should clearly define the fault tolerance techniques proposed and should address the concerns expressed above including the non-invasive application to scalable heterogeneous computing systems. The report should define how the fault tolerant techniques will be applied in Phase II, what metrics will be used to measure the degree of fault tolerance, and what guarantees can be made about the resulting system-level fault tolerance for various degrees of fault tolerant system components.

PHASE II: Proposed fault tolerance techniques should be developed and applied to a heterogeneous scalable system to demonstrate the fault tolerance approach. Significant test data should be gathered and reported against the metrics proposed to validate the assumptions on actual applications of interest to DoD. Plans for commercialization of the approach and availability to DoD should be developed in Phase II.

COMMERCIAL POTENTIAL: There is a growing demand for fault tolerant systems in industrial and medical application areas to be comprised of heterogeneous off-the-shelf components. These components will not be designed with fault tolerance attributes but must be combined to produce a fault tolerant system. Many of the fault tolerant characteristics are common between defense applications and commercial applications and both markets wish to use the same technology base.

REFERENCES:
1) World Wide Web DARPA/ITO Home Page, URL http://www.ito.darpa.mil
2) The High Performance Computing and Communications "Blue Book" for 1995 and 1996, URL http://www.hpcc.gov

DARPA SB962-062 TITLE: Semantically-Based User Interface Management Tools for Dynamic Languages and Mobile Code

CATEGORY: 6.2 Exploratory Development; Computing and Software

OBJECTIVE: Develop a high level toolkit appropriate for use with emerging dynamic languages and mobile code systems (e.g. Dylan, Lisp, Java, Smalltalk) which allows the interface between a program and its users to be expressed in high level terms appropriate to the semantics of the program.

DESCRIPTION: Research and develop tools which will dramatically raise the level of abstraction at which Human Computer Interaction is managed. Today's systems are still largely concerned with the low level details of screen management and do not provide seamless integration between the interface and the semantics of the program. The toolkit developed should provide extensible interfaces to existing User Interface toolkits and should establish a framework within which it will be possible to transform existing program interfaces to exploit future interfaces technology using speech, natural language, and visual recognition. Efforts should be situated in the context of advanced high level dynamic languages and/or mobile code systems (e.g. Smalltalk, Dylan, Java, Lisp, etc.).

PHASE I: In detail, define the framework, its protocols and layering structure, its techniques for interfacing to lower level toolkit, and its method of relating program semantics to interface presentation.

PHASE II: Create an implementation of a tool that embodies the design developed in Phase I. Demonstrate its ability to operate in a highly dynamic environment with adequate performance. Outline and document the techniques for mating the toolkit with other underlying frameworks and evolving its functionality as new interface technologies become available.

COMMERCIAL POTENTIAL: The market for mobile code systems use to provide high level interfaces within the World Wide Web is beginning to grow dramatically; Java (from Sun) represents an early attempt to provide tools for this environment. However, as yet this is a very low level framework with few, if any, design tools. Dynamic languages (e.g. Java, Lisp, Smalltalk, Dylan) are perceived as the obvious languages for developing such applications; the established members of this family have a longstanding, committed niche market in the Artificial Intelligence and financial communities. These provide a natural early market for the technology.

DARPA SB962-063 TITLE: Design Rationale Capture

CATEGORY: 6.2 Exploratory Development; Computing and Software

OBJECTIVE: Develop a software development environment integrating the capture of design rationale into the normal collaborative discussions among a team of designers.

DESCRIPTION: Design rationale includes descriptions of how a system is structured, why it is structured that way, and how it evolved to its current form. Without knowledge of what things exist and why they exist the way they do, a system upgrade team is left with little more than "system archeology" to guide their actions.

To date, most design rationale is lost because: 1) designers are forced to use specialized, formal notations to express design rationale; 2) they are forced to step outside of their normal workflow in order to enter design rationale; and 3) tools do not exist to retrieve appropriate elements of the rationale in convenient ways.

The keys to effective rationale capture are to capture the information at the time it is generated, with as little burden on the originating design team's time as possible (preferably none), and with little or no impact on the way the design team works. The uses of speech recognition and natural language based retrieval technologies are possible points of leverage in realizing these goals. Similarly the use of a large software design knowledge base may make rationale capture simpler by allowing developers to refer to things the system already knows, rather than having to create lengthy descriptions.

The environment developed should address any of the following:

(1) *Integration with Collaboration Tools*: Integrating rationale capture into a framework of electronically mediated group collaboration tools so that interesting elements of design discussions can be captured and indexed with little additional guidance from the users. The collaboration environment should be based on E-mail, the World Wide Web, desktop video conferencing, or other technologies which will form the normal communication environment for cutting-edge researchers in the next few years.

(2) *Full Text Natural Language (NL) Based Retrieval*: Using full text and/or natural language based retrieval tools to facilitate indexing and retrieval.

(3) *Software Design Knowledge Base*: A broad coverage knowledge of standard, abstract software structures and transformations to which designers may easily refer.

Rationale should be captured and stored in a design web which highlights key relationships among the various artifacts comprising the product.

PHASE I: In detail, define the techniques to be employed and the tools to be used in effecting these techniques. For (1) *Integration with Collaboration Tools,* define the collaboration environment and the extra interactions required by the users to cause rationale elements to be captured. For (2)*Text and NL Based Retrieval*, define the retrieval tools to be used and assess their coverage. For (3)*Software Design Knowledge Base,* define at least the top levels of the taxonomy of structures and transformations.

PHASE II: Create a prototype implementation of the environment defined in Phase I. Demonstrate its ability to handle rationale discussions about systems of modest complexity. Outline techniques for extending the system and scaling it to handle systems of greater complexity.

COMMERCIAL POTENTIAL: Rationale capture is one of the key points of leverage in managing the evolution of complex systems. Increasingly, software is not being created de novo but rather is built by modifying or extending existing components to meet new needs. Software developers are facing the task of maintaining large-scale, complex systems for decades in an environment where contributors do not stay on the project for more than a few years. Organizations managing such projects have recognized the need to capture and manage design rationale, but they cannot today find practical tools for the task. A development environment which seamlessly captures design rationale will therefore meet a receptive audience. This capability is particularly critical to building evolvable defense software systems.

DARPA SB962-064 TITLE: Stabilization of Diode Laser Arrays

CATEGORY: 6.3 Advanced Development; Materials, Processes and Structures

OBJECTIVE: Develop active control to stabilize diode laser arrays against chaotic oscillations. Stabilized arrays can operate at higher gain and at higher packing densities.

DESCRIPTION: Diode laser arrays are known to become unstable under conditions of high gain and/or high packing density in integrated structures. Chaotic oscillations occur in these systems due to the nonlinearity of the diode laser and coupling between elements in the array. Currently this type of instability is the primary barrier to producing high density and high gain arrays in integrated optical devices. Recently it has been demonstrated that chaotic oscillations can be controlled by small, but intelligent, perturbations to the state of the system or to an accessible parameter governing the dynamics. Therefore, it is highly probable that spacial instabilities such as those in diode laser arrays can also be controlled by perturbing a single element or the elements along a single edge of the array.

PHASE I: Simulate a diode laser array with electronic elements. This electronic testbed would require data acquisition regarding the state of the array. In addition, it would be necessary to modify the parameters governing one or more elements of the array in real-time in response to an external control signal. The external signal would be provided by a programmable device capable of simulating different control algorithms. This testbed is intended to be delivered to Weapons Sciences Directorate (WSD) for use as a facility for continuing research and testing in spacio-temporal chaos control of interest to RDEC. Expertise would be available from WSD for designing chaos control algorithms.

PHASE II: Fabricate a diode laser array. Provisions would be made for an external control signal to effect stabilization via the control algorithm chosen in Phase I. A demonstration would show the controlled diode laser array to be stable at high gain and packing density significantly beyond the limit of uncontrolled arrays.

COMMERCIAL POTENTIAL: This work will contribute to all areas both military and commercial where laser diodes are utilized and in particular where additional power and stability is needed. Stabilized arrays can operate at higher gain and at higher packing densities than otherwise possible.

REFERENCES:
1) Ott E., C. Grebogi, and J.A. Yorke, "Controlling Chaos," Phys. Rev. Lett. 64: 1196-1199, 1990.
2) Winful H., "Instability Threshold for an Array of Coupled Semiconductor Lasers," Phys. Rev. A, Vol 46, No. 9, 6093-6094:1992.

DARPA SB962-065 TITLE: Photonic Systems for Tunable True Time-Delay

CATEGORY: 6.2 Exploratory Development; Electronics

OBJECTIVE: Provide a true time-delay device for large tunable delays of short and ultrashort optical pulses in a compact structure that exhibits very low loss. Pulse distortion should also be largely absent.

DESCRIPTION: A novel photonic system is sought to provide true time-delay transmission paths for arrayed microwave signals. The envisioned system will consist of a robust electrically-controlled photonic delay device for operation in the near-

to mid-infrared (approximately 1.5 micron wavelength) and will be capable of operating in the gigahertz regime, with operating voltages consistent with those used in TTL logic. The optimum design will maximize performance versus size (large delay produced by a device with minimal dimensions). Minimal distortion of optical pulses in combination with large tunable delay and very low loss is crucial to expected device performance. It is expected that a large number of devices, each of which may exhibit smaller tunable delays, may be serially addressed in order to realize a large tunable delay. A robust material, such as semiconductor, is expected for use in the device design, so that the device may suitably be incorporated in an integrated circuit environment. In short, a design that is compatible with an information handling environment based on digitized short and ultrashort optical pulses is sought. In addition, an in-depth experimental exploration of a family of devices is expected, along with an evaluation of the performance of different structures with regard to the following parameters: sensitivity of delay to controlling electrical signal, distortion of optical pulses under delay operation, and transmission loss of device.

PHASE I: Characterize materials and designs for use in devices. A feasible design of an optimum prototype structure is expected. Evaluate relation of devices to Army needs and applications.

PHASE II: Build and experimentally test prototype structure and evaluate performance of operating device. Report on feasibility of building micro-array of individually-addressed devices integrated on microchip for use in optically controlled phased-array radar. Provide report on manner in which such a device will fit into existing Army technology and future Army systems.

PHASE III: Demonstrate incorporation of micro-array device in a small system. Show ability to control an actual system in which true time-delay is required. Evaluate transitioning to Army applications such as agile phased array radar and optically controlled beam steering. Show capacity to synchronize optical devices operating in gigahertz regime.

COMMERCIAL POTENTIAL: This work will contribute to all areas both military and commercial where a novel photonic system can provide true time-delay transmission paths for arrayed microwave signals. The envisioned system will consist of a robust electrically-controlled photonic delay device for operation in the near- to mid-infrared (approximately 1.5 micron wavelength) and will be capable of operating in the gigahertz regime, with operating voltages consistent with those used in TTL logic. The optimum design will maximize performance versus size (large delay produced by a device with minimal dimensions). This concept has applications in a wide range of microwave radar and communications fields.

REFERENCE: Zmuda H. and E. N. Toughlian, "Photonic Aspects of Modern Radar," Artech House, 1994.

DARPA SB962-066 TITLE: <u>Application of Adaptive Array Processing to Cellular Base Station Antennas</u>

CATEGORY: 6.2 Exploratory Development; Sensors

OBJECTIVE: Define and evaluate performance of a notional, low-cost base station array configuration and supporting adaptive array processing applied to the uplink and downlink.

DESCRIPTION: If a cellular base station employs an array of elements in a notional configuration, then spatial directivity and adaptive nulling can be applied to uplink and downlink processing. The algorithms of interest would have to place and maintain beams on moving sources while simultaneously nulling interference such as co-channel sources in other cells and intermod products from other base stations. Algorithm design should be robust to multipath effects and urban environments. Algorithm design should minimize computational complexity. Performance analysis should include comparison of Signal-to-Interference-plus-Noise Ratio (SINR) on typical mobile sources with and without adaptive array processing, and evaluation of the impact of adaptive array processing on link capacity.

PHASE I: Provide detailed definition of base station array and the supporting adaptive processing algorithms and processor throughput requirements.

PHASE II: Provide full simulation of system performance including detailed terrain effects. Devise simple uplink experiment to demonstrate adaptive array performance.

COMMERCIAL POTENTIAL: As the PCS market continues to grow, the need for increased capacity without degradation in service quality is likely to require the use of adaptive antennas in base stations. Several current commercial concerns have invested in adaptive array research, but a product has yet to gain a foothold in the marketplace. Once an adaptive array product gains acceptance in the marketplace, the potential international sales volume is very large.

DARPA SB962-067 TITLE: Detection and Estimation in Airborne Space-Time Adaptive Radar

CATEGORY: 6.2 Exploratory Development; Sensors

OBJECTIVE: Develop Space-Time Adaptive Processing (STAP) algorithms and accompanying detection and estimation algorithms that are robust to non-Gaussian amplitude statistics in an airborne surveillance radar environment.

DESCRIPTION: As military radar hardware developers leverage progress in miniaturized digital receiver technology, and massively parallel embedded processing capabilities, the application of sophisticated digital signal processing applications such as STAP will be feasible in fielded systems. Algorithms will be required that provide Constant False Alarm Rate (CFAR) performance without significantly degrading radar detection performance in a variety of clutter background types. Radar clutter signals are known to have non-Gaussian amplitude statistics. STAP is not optimum when the clutter statistics are non-Gaussian resulting in clutter undernulling. The resulting composite background of Gaussian receiver noise and non-Gaussian clutter residue is a challenge to CFAR detector design. A combination of STAP algorithms and target signal detection and estimation algorithms are required that are robust to a variety of pre- and post-adaptation clutter background distributions.

PHASE I: Provide detailed design of STAP and detection algorithms and provide detection performance analysis using a generic clutter simulation.

PHASE II: Evaluate algorithm performance on site-specific simulation data, and live data collected on the DARPA Mountaintop Program. Implement detailed simulation of scenarios specified by the program office using Rome Laboratory STAP for site-specific data simulation.

COMMERCIAL POTENTIAL: Future business opportunities will be aimed at DoD and commercial advanced communications systems.

DARPA SB962-068 TITLE: Applications and Beamforming with Small, Wide-Band Elements

CATEGORY: 6.2 Exploratory Development; Sensors

OBJECTIVE: Development and/or application of small, low-noise, wide-band antenna elements.

DESCRIPTION: The performer will carry out research and development leading to the deployment of advanced antenna apertures consisting of small, low-power, wide-band (<20 MHz to >2 GHz) elements. Efforts may include development and breadboard testing of new elements or systems applications of existing elements. The system application should involve combining these elements into array apertures characterized by wide-bandwidth and high beam-steering accuracy without significant overhead associated with power or cooling.

PHASE I: The performer will develop/define the elements to be used and analyze the performance of an array of these elements in a communications application. Priority is to be placed on the operating bandwidth and beam-steering accuracy of the aperture, and on packaging issues (size, weight, power).

PHASE II: The performer will conduct breadboard testing of the concepts developed in Phase I. The objectives of these tests will be to demonstrate the feasibility of deploying such an aperture and to characterize the expected performance.

COMMERCIAL POTENTIAL: The concepts to be explored in this SBIR project have tremendous potential for commercial implementation. Evolving communications networks, such as cellular and PCS, will rely on small, inexpensive, high-performance antennas to perform in a cost-effective manner. The antennas developed in this program will have direct commercial application in this field.

DARPA SB962-069 TITLE: Lightweight Electronically Steerable Antennas

CATEGORY: 6.2 Exploratory Development; Sensors

OBJECTIVE: Microwave antennas which are used for fire control may have dimensions as large as 100 wavelengths. This SBIR topic seeks to reduce the weight of these antennas by 1) relaxing requirements of physical stress (for example space or aerostat applications); 2) relaxing FOV requirements for electronic scan; and 3) using new feed and array construction techniques.

DESCRIPTION: The performer will develop new feed and array designs which achieve very large savings in weight while maintaining a large power-aperture product for fire control radar. Use of fiber optic feeds, space feeds, and composite construction techniques are among the technologies which could be considered.

PHASE I: Develop concepts and define critical experiments.

PHASE II: Fabricate array and feed subsections to validate weight estimates and performance.

COMMERCIAL POTENTIAL: Weight usually equates with cost, and in both space and terrestrial applications, microwave antennas are used for improving signal reception. Thus this technology would give a wide range of application in cost reduction.

REFERENCE: The Antenna Handbooks.

DARPA SB962-070 TITLE: Micro Sensor Systems

CATEGORY: 6.2 Exploratory Development; Sensors

OBJECTIVE: Identify technologies and concepts for development of extremely small sensor systems for use as stand alone or integrated into small robots and UAVs.

DESCRIPTION: There is a need for small sensor systems which provide real-time intelligence to small units or individuals. This program is focused at research and development leading to the development of small, light-weight, low-power sensor systems for surveillance and targeting applications. Efforts may address any field of design for which significant leverage can be demonstrated. However, the areas of advanced sensors, low-power electronic systems design, and low-power wide bandwidth data links is of particular interest.

PHASE I: This phase will define/identify/develop technologies, processes, architectures, and system concepts for micro sensor systems. Expected output are: system concepts; performance assessments; size, weight, and power trades; and development initiatives.

PHASE II: Phase II focus is on small scale validation experiments for promising concepts from Phase I.

COMMERCIAL POTENTIAL: The development of small sensor systems have commercial potential for many markets. High performance sensor systems can be used by the security industry as well as support the personal communication services infrastructure.

DARPA SB962-071 TITLE: Innovative Missile Warhead Kill Mechanisms

CATEGORY: 6.2 Exploratory Development; Conventional Weapons, Directed Energy Weapons

OBJECTIVE: Predicted lethality performance (via simulation) and prototype design specifications for warhead leading to prototype development.

DESCRIPTION: The next generation of advanced cruise missile and aircraft threats may employ electronic countermeasures which can enforce miss distances that exceed the effective radius of conventional air-to-air and surface-to-air missile (AAM/SAM) warheads. Concepts for innovative kill mechanisms that provide high probability of sure kill against evolving threats are of interest to DARPA. Novel designs may include, but are not limited to, mass-focused high explosive warheads, fragment shape innovations, high power microwave (HPM) warheads, or submunition packages ("mother-daughter" designs). Current and planned Army, Navy, and Air Force AAM/SAM airframes may be considered potential candidates to receive the kill mechanism upgrade. Concepts which provide engageability against threats flying down to sea level, at speeds up to Mach 3, and at all aspects is desirable. No modifications to safety, handling, and maintenance procedures should be required. Changes in requirements for fire control and/or surveillance sensors are discouraged.

PHASE I: Provide a detailed concept feasibility assessment. Include preliminary effectiveness simulation results and a development roadmap for the recommended technology.

PHASE II: Provide detailed effectiveness analysis. Perform requirements flowdown for the warhead fuse, associated fuse hardware, and support from guidance subsystems. Indicate how warhead mechanism will meet airframe volume, dimensional, and mass constraints for the warhead subsystem.

COMMERCIAL POTENTIAL: Future business opportunities will be aimed toward DoD needs.

DARPA SB962-072 TITLE: New Long-Range Air Target ID Techniques using RADAR

CATEGORY: 6.2 Exploratory Development; Sensors

OBJECTIVE: Develop advanced combat identification techniques for implementation in advanced radar systems.

DESCRIPTION: The performer will carry out research and development of advanced combat identification concepts capable of long-range detection of air targets. Techniques developed will be suitable for implementation on either advanced fire-control or surveillance radars. Techniques for consideration include, but are not limited to, radar signal modulation, Synthetic Aperture Radar (SAR), ISAR, and high-range resolution profiling. Both cooperative and non-cooperative techniques will be considered.

PHASE I: Develop a combat ID concept capable of classifying air targets at long ranges (commensurate with the kinematic ranges of projected missile technology). In detail, define the proposed algorithm and implementation approach.

PHASE II: Implement an appropriately-scaled algorithm on a radar selected in consultation with DARPA. For example, an algorithm designed for a surveillance radar might be tested on ARPA's Radar Surveillance Technology Experimental Radar (RSTER) currently operating at the Pacific Missile Range Facility. Data will be collected and the efficacy of the algorithm evaluated.

COMMERCIAL POTENTIAL: Target identification techniques have commercial application in areas where extraction of a desired object from background noise and nuisance objects is required. Examples include search-and-rescue operations and feature extraction in remote sensing operations.

DARPA SB962-073 TITLE: Selective Energy Conversion into Mechanical or Electrical Power

CATEGORY: 6.2 Exploratory Development; Aerospace Propulsion and Power; Environmental Quality; Materials, Processes and Structures; Sensors; Ground Vehicles; Manufacturing Science and Technology

OBJECTIVE: Create and demonstrate concepts for scavenging power and converting high energy -density fuels into electrical power for small systems.

DESCRIPTION: In most systems size and weight of the power source are key issues affecting system design and overall performance. Also, it is often desirable to selectively use and combine discrete energy units to generate the necessary electrical or mechanical power. Present power sources have inadequate energy densities and selectivity to be used efficiently in several target applications. Novel methods of creating high energy density microsystems for storing and selectively converting energy into mechanical or electrical power are needed. Likewise, conversion by thermophotovoltaic (TPV) systems can be improved by the capability to manufacture low-cost, narrow band gap photovoltaic cells.

It is anticipated that the necessary power sources will take advantage of the high energy densities available from combustion or direct conversion of chemical energy into mechanical or electrical power. These power sources would also take advantage of microelectromechanical systems (MEMS) technology in order to minimize size and weight. Additionally, the MEMS technology would be used to create discrete power units which could be addressed individually to generate a fixed amount of power or addressed in larger groups to produce the required output powers. In short, the systems would have the following features: high energy density, small size, low weight, individually addressable power units, and minimized system cost.

These highly efficient, selectively addressable power sources are necessary for use with micro-Remotely Piloted Vehicles (RPVs), taskable machines, and microsensor systems that have been deployed in the field.

TPV is a promising new power technology that converts radiant heat into electricity. Successful development of this technology requires photovoltaic cells that are both low-cost and have a narrow bandgap. Silicon photovoltaic cells are low-cost, but the relatively short 1 micron cutoff wavelength of silicon and its indirect bandgap restricts TPV systems to either low efficiency or use of high temperature (2000° C) sources that present substantial materials issues. These cells need to have the low-cost associated with silicon concentrator cells along with the ability to collect radiation at wavelengths longer than one micron. This will enable the use of lower temperature emitters and improve efficiency with broad-band emitters operating at high temperatures. Wavelength cutoffs of 1.5 microns or greater are sought.

PHASE I: Define and demonstrate the critical aspects of the energy conversion system. For TPV, define the manufacturing process and demonstrate critical processes.

PHASE II: Develop and demonstrate an engineering prototype, show robustness of the design or process, and identify customer.

COMMERCIAL POTENTIAL: Power for remote portable and miniature equipment, and mobile systems.

REFERENCES:
1) The First NREL Conference on Thermophotovoltaic Generation of Electricity, Copper Mountain, CO (1994), AIP Press.
2) The Second NREL Conference on Thermophotovoltaic Generation of Electricity, Colorado Springs, CO (1995), AIP Press.

DARPA SB962-074 TITLE: Kinematic Sensor/Sensory Environment and Multi-Axis Workstation Interface System for Synthetic Environment Operators

CATEGORY: 6.2 Exploratory Development; Modeling and Simulation, Human Systems Interface

OBJECTIVE: 1) Create a coupled sensor system and head mounted display with maximum freedom from umbilical. 2) Provide realistic environmental sensory stimuli for virtual environments. 3) Create and demonstrate a new device for natural interaction and control of virtual objects for use in engineering application.

DESCRIPTION: There are three aspects to Virtual Reality (VR) environments to be used in the systems engineering of complex systems: 1) An effective, minimally-intrusive system is needed that measures an operator's real-time kinematic state, interfaces with a system that correspondingly manipulates an icon of the operator in a VR environment and then displays the resulting VR view of the icon to the operator via a head-mounted display. All visual and sensor data would be transmitted using either infrared or high frequency [GHz range] radio signals so that the operator is untethered and able to walk, run, or crawl as necessary on the synthetic environment mobile platform. 2) A means for incorporating realistic environmental effects such as in a casualty--smoke, fire, heat, overpressure (from an explosive), sound, smell, texture, etc. is desired. 3) Novel, multi-axis workstation interfaces that can be used to control multiple degree of freedom systems such as mobile platforms, solid objects (e.g., virtual tools), operator icons, robot manipulators and effectors, and others. These workstation interfaces shall preferably be designed to extend human physiological proprioception and thus provide intuitive haptic interaction with the synthetic environment. The new systems shall capitalize on recent developments in Microelectromechanical Sensors (MEMS) and Actuators, such as Rotary Encoders, Multi-Axis Accelerometers and Strain Sensors, and shall use novel kinematics designs to: Minimize system cost, Increase system reliability and ruggedness, Minimize size, Minimize power consumption, and Provide an intuitive interface that basically extends physiological proprioception into the synthetic environment.

PHASE I: Define and demonstrate sensor suit and integrate with engineering application. Define wireless requirements and conceptual design. Investigate and report possible techniques and technology for providing environmental sensory stimuli. Investigate, prototype, and report concepts for the natural manipulation of virtual objects for use in engineering applications.

PHASE II: Integrate wireless sensory suit concepts and demonstrate for engineering application. Implement and demonstrate various stimuli techniques discovered in Phase I. Develop and demonstrate a multi-axis engineering prototype and implement for evaluation of design and engineering utility.

COMMERCIAL POTENTIAL: The development of these technologies will have immediate positive impact on commercial markets particularly in the entertainment industry and the training communities where realism is essential. Existing mechanisms are too limited for heavy production use in large and complex engineering projects. "Space mice," Polhemus devices, conventional mice, etc. are not accurate, reliable, or as easy to use as they could be. All current users of interface devices could potentially utilize new devices and the market, therefore, is significant.

DARPA SB962-075 TITLE: Real-Time Closed-Loop Control of Variable Geometry Fluid Mechanical Surfaces

CATEGORY: 6.2 Exploratory Development; Air Vehicles, Surface/ Under Surface Vehicles

OBJECTIVE: Develop and demonstrate an engineering prototype control surface with minimum power requirements, minimum negative influence on signature, and maximum controllability.

DESCRIPTION: The performance capabilities of future "flight" vehicles will be significantly enhanced by the use of "smart" or adaptive structures. Such structures will have the ability to sense operational and environmental stimuli and actively optimize system response to meet or enhance structural, acoustic, or fluid dynamic performance. For example, advanced submarine stern configurations will require a variety of control surfaces to actively manage aft body boundary layer flow, vorticity, propulsor inflow and intrapropulsor flow, as well as vehicle attitude. Ultimately, real-time sensing of flow conditions over attitude control

surfaces could be utilized to implement advanced camber control algorithms for increased lift without flow separation and for improved tactical maneuvering performance with reduced acoustic signature. Propulsor efficiency and associated hull boundary layer/vorticity interaction could be controlled to similar advantage. Indeed, entire networks of flow sensors could be envisioned which could subsequently provide global information for orchestrated control of attitude control appendages, flow control and anti-vorticity vanes, as well as propulsor vanes and stators, for aircraft and marine vehicle applications.

Elements of a proposed technical approach should include, but not be limited to: Integrated Actuation of Discrete Chordwise Foil Segments, Integrated Surface Pressure Sensor Network to Monitor the Boundary Layer, Surface Actuation Capability to Induce or Prevent Formation of Turbulent Flow, and Servo Control System to Optimize Camber for Prescribed Surface Pressure Distributions and/or Boundary Layer Development.

PHASE I: Develop and demonstrate an engineering prototype.

PHASE II: Develop and demonstrate the concept as a control system on an airplane, torpedo, ship, or submarine model of sufficient scale to determine suitability for actual implementation.

COMMERCIAL POTENTIAL: Significant commercial potential for application to commercial aircraft to improve fuel efficiency and reduce wing/flap mechanical complexity.

DARPA SB962-076 TITLE: Advanced Systems for Detecting and Localizing Mines or Submarines

CATEGORY: 6.2 Exploratory Development; Surface Vehicles, Sensors

OBJECTIVE: Develop shipboard system for effective detection and localization of submarines either underway or sitting on the bottom; or floating, moored and buried mines in littoral waters.

DESCRIPTION: Joint Vision 2010 lays out four new concepts that will guide future military operations. One of these concepts, called Dominant Maneuver, requires mobile capabilities which allow widely dispersed forces to quickly converge to achieve their mission. Ship operations in support of Dominant Maneuver demand safe and secure movement in littoral waters. Support for forced entry involving amphibian operations requires shipboard systems capable of detecting and localizing submarines or floating, moored and buried mines in shallow waters. This research and development initiative would lead to system concepts compatible with shipboard operations which offer promise to effectively detect and localize submarines or mine threats.

Efforts may embrace a variety of sensor and geographic positioning themes. Innovative concepts which do not limit the flexibility and mobility of ship operation are of special interest.

PHASE I: Define the proposed concept in sufficient engineering detail to demonstrate feasibility and quantify expected performance measures.

PHASE II: Proof-of-principle demonstration.

COMMERCIAL POTENTIAL: Concepts developed may have commercial utility for location of sunken objects in connection with offshore oil and gas exploration and production.

DARPA SB962-077 TITLE: Low-Cost Miniature Active Radar Frequency (RF) Package

CATEGORY: 6.2 Exploratory Development; Sensors

OBJECTIVE: Design and fabricate of a low-cost, miniature, active RF package capable of emulating the signature of an aircraft.

DESCRIPTION: Although active RF enhancement packages have been designed and fabricated, the challenge remains to fabricate an active RF package that is very small, affordable and can generate the radar cross section of an aircraft. The RF package is envisioned for possible use in a low-cost miniature decoy. Efforts should address the frequency, power requirements, and cost associated with proposed designs. Particular interest is in packages that are capable of generating false target signatures in the frequency range of 0.1 and 18 Ghz. Technologies that produce jet engine modulation (JEM) and scintillation are desirable, but are not required.

PHASE I: Produce a detailed design, cost estimate, and a brassboard system for a laboratory demonstration that can be used by the Government for system evaluation (e.g., frequency output, power output, duty cycle, and efficiency).

PHASE II: Fabricate and demonstrate the RF payload in flight configuration. Verify unit cost estimates.

COMMERCIAL POTENTIAL: The development of RF enhancement payload technologies that are small and affordable could be used in the general aviation marketplace to enhance the signature of small commercial aircraft to increase aircraft "visibility" and enhance safety.

DARPA SB962-078 TITLE: High Speed Ships and Boats

CATEGORY: 6.2 Exploratory Development; Surface/Under Surface Vehicles

OBJECTIVE: Create new hull and/or propulsion system concepts for ships and boats.

DESCRIPTION: Research and development leading to new ship concepts is sought. Advanced integrated hull and propulsion system concepts for ships and boats are of principal interest. Fast sealift for rapid deployment of forces and their heavy equipment (e.g., tanks and other vehicles) is of particular interest. Fast boats for Special Operations Forces are also of particular interest.

Advanced concepts for high speed dynamically supported ships, new hull concepts for high speed boats, and high power density prime movers for ships and/or boats are also of individual interest. In all cases, improved seakeeping, reduced motions and benefits to survivability (both signature(s) reduction and passive features) are important.

PHASE I: Analytical prediction of performance of the concept(s) proposed.

PHASE II: Experimental verification of the analytic predictions.

COMMERCIAL POTENTIAL: There is great interest in the "middle market" for high speed ocean transportation. That is, high value cargoes which, if moved quickly, could reduce inventory carrying charges. There is also a fast ferry market which allows transit over large distances but which does not require the passengers to have cabins because an overnight stay is not required.

DARPA SB962-079 TITLE: Supporting Technologies for Uninhabited Tactical Aircraft (UTA)

CATEGORY: 6.2 Exploratory Development; Control Station Technologies, Air Vehicle Technologies, Manufacturing Techniques, Communications, Military Operations

OBJECTIVE: Develop enabling technologies in support of affordable UTA systems.

DESCRIPTION: UTAs are envisioned as general purpose, reusable, tactical air vehicles which combine the best advantages of Unmanned Aerial Vehicles (UAVs) and manned aircraft. Relocating the operator to an optimal information environment (control station) outside the vehicle eliminates human physiological constraints and risk factors imposed on manned aircraft, while retaining the inherent decision making and judgment of an operator "in-the-loop." Thus, UTA systems offer the potential for a greatly expanded set of mission options including missions too hazardous for manned assets, or targets inappropriate for cruise missiles. A fully implemented UTA system encompasses a wide variety of technologies. Proposals are sought to define and develop one or more enabling or otherwise critical technologies that support the evolution of a UTA system. Technology areas include, but are not limited to: 1) human-vehicle interface, including control station design; 2) refueling of unmanned vehicles; 3) low probability of intercept (LPI) and anti-jam communications for multiple air vehicle control; 4) air vehicle manufacturing techniques that capture the affordability and performance potential of unmanned systems; 5) intelligent systems/decision aids; and 6) technologies which significantly enhance system or vehicle affordability.

PHASE I: Conduct a study to define, validate and exploit one or more enabling technologies for a UTA system. Quantify the benefits of the technological approach via analysis, and/or simulation, including an assessment of capability, and impact on overall system affordability.

PHASE II: Extend development and provide functional demonstrations to validate the technological approach.

COMMERCIAL POTENTIAL: The development of enabling UTA technologies will evoke technology advances from within the commercial sector. Further advancement of these enabling technologies could lead to advances in a variety of areas, including human-computer interfaces, intelligent aids, high resolution displays, intelligent communications networks, and low-cost air vehicle manufacturing techniques.

DARPA SB962-080 TITLE: Micro Unmanned Aerial Vehicle (UAV) System Design and Operation

CATEGORY: 6.2 Exploratory Development; Air Vehicles; Command, Control, and Communications

OBJECTIVE: Develop a very small (micro) UAV system - maximum characteristic dimension of 15 cm or less - for unique military applications and assess its operational utility.

DESCRIPTION: The micro UAV represents a new class of flight vehicle with inherent potential to accomplish a number of unique, difficult military missions. Mechanization of flight at these small scales has not yet been achieved under other than experimental conditions, at best. Flight vehicle concepts and designs should address critical performance attributes such as range, speed, hover, agility, and covertness, but the operational approach must address all relevant implementation issues. Operating concepts to be examined will stress those that fulfill military missions, with priority placed on missions that currently cannot be accomplished in other ways. System concepts will be evaluated on the basis of technical feasibility, ease of implementation, operational utility, and affordability. Phase I participants may wish to team with subsystem technologists and/or other offerors to improve their competitive position for Phase II and ensure a successful vehicle integration and demonstration.

PHASE I: Develop and mature system and operating concepts for proposed micro UAV candidates. Perform analysis to demonstrate system feasibility and evaluate performance parameters. As part of the design, credibly estimate vehicle cost metrics.

PHASE II: Finalize design, fabricate and demonstrate a prototype micro UAV. Perform necessary testing, including sample mission scenarios, to assess operational effectiveness.

COMMERCIAL POTENTIAL: The development of a prototype micro UAV can provide dual-use capabilities in several areas. Remote sensing and travel within hazardous environments (nuclear, chemical, biological) would include sampling in waste storage facilities as well as air sampling for toxins during firefighting operations. Disaster rescue operations would benefit from a small remote sensor with the size and agility to maneuver through areas that might be too unstable for human operations. Security operations are another obvious area for the potential use of a micro UAV.

REFERENCES:
1) Micro Unmanned Aerial Vehicles: Results of a Workshop, Advanced Research Projects Agency (ARPA), 1995.
2) Future Technology-Driven Revolutions in Military Operations, DB-110-ARPA, 1994.

DARPA SB962-081 TITLE: Micro Unmanned Aerial Vehicle (MUAV) Critical Technologies

CATEGORY: 6.2 Exploratory Development; Air Vehicles; Command, Control, and Communications; Aerospace Propulsion and Power; Electronics; Manufacturing Science and Technology; Chemical and Biological Defense; Sensors

OBJECTIVE: Design and demonstrate individual or integrated critical flight enabling technologies for an MUAV. These technologies could include navigation, microelectronic integration, advanced microsystem communications, small scale flight control, and power/propulsion technologies. Other relevant technology areas, particularly those unique to enabling flight of MUAVs, will also be considered.

DESCRIPTION: The fabrication and demonstration of an MUAV with maximum characteristic length on the order of 15 cm will require development or adaptation of a broad range of technology areas. Particularly problematic are areas such as navigation, small scale aerodynamics and flight control, where research exists that could be applied innovatively to achieve combinations of the critical performance perimeters of speed, endurance, agility, and hover. Potential battery, fossil fuel and other power sources will be required to possess both high energy density and the ability to achieve relatively high energy output rates. Fuel efficient cruise and loiter miniature propulsion systems that operate in the low to medium subsonic speed regime, and that are acoustically and visually unobtrusive are of particular interest. Elements that can contribute to novel, synergistic designs - where components are multi-functional (e.g., electronic elements that also serve as primary structure) - are necessary to address severe weight and volume constraints imposed on MUAVs and will be given priority. Integration of electronic functions such as communications, navigation, sensors, processors, etc. will also be critical in achieving a UAV of this size. Proposals should focus on describing credible novel technology or integrated system concepts and designs.

PHASE I: Identify and refine technical approaches and perform experiments and/or demonstrations to validate concepts or designs.

PHASE II: Develop and test flight article components, including possible integration into a near term demonstration UAV. This phase may require teaming with other technology or system developers to assess integration issues and provide design credibility.

COMMERCIAL POTENTIAL: The development of micro UAV component technologies will be applicable to many commercial fields. Remote sensing and travel within hazardous environments (nuclear, chemical, biological) and for disaster rescue operations are potential applications of this technology in the commercial world.

REFERENCES:
1) Micro Unmanned Aerial Vehicles: Results of a Workshop, Advanced Research Projects Agency, 1995.
2) Future Technology-Driven Revolutions in Military Operations, DB-110-ARPA, 1994.

DARPA SB962-082 TITLE: Modeling a Tip Vortex with Mass Injection

CATEGORY: 6.2 Exploratory Development; Materials, Processes and Structures

OBJECTIVE: Analyze the impact of tip jet mass injection on the aerodynamic characteristics of the rotor by developing a mathematical model of the tip vortex generated by a lifting rotor blade, with injection of gas (turbofan engine core and bypass flow, mixed) into the tip vortex by the tip jet nozzle.

DESCRIPTION: Tip jet reaction drive rotors offer considerable promise for military and commercial helicopter and other vertical take-off and landing (VTOL) aircraft concepts. Conventional helicopter hover analysis computer programs utilize lifting surface aerodynamic theory, which requires mathematical modeling of the rotor wake, including the rotor blade tip vortices. However, the effects of mass injection into the tip vortices by reaction drive tip jets have not been incorporated into these mathematical models.

This model must provide tip vortex diameter, strength, and roll-up characteristics, and radial and axial coordinates of the trajectory of the tip vortex as trailed by the lifting rotor blade. A computational fluid dynamics analysis may be used.

PHASE I: Develop a mathematical model of the tip vortex generated by a lifting rotor blade, with injection of gas into the tip vortex by the tip jet nozzle.

PHASE II: Incorporate the results of this modeling into an industry-accepted helicopter rotor hover performance analysis computer program.

COMMERCIAL POTENTIAL: Commercial helicopter market.

DARPA SB962-083 TITLE: Flexible Polymeric Waveguides for Optical Display Substrates

CATEGORY: 6.2 Exploratory Development; Electronics; Materials, Processes and Systems; and Command, Control, and Communications

OBJECTIVE: Demonstrate novel waveguide materials that can be used for display substrates.

DESCRIPTION: One of the desirable attributes of a future display is to achieve a paper-like functionality that allows a display to be folded into a hand-sized form factor or a wall-sized display that can be rolled up like a projector screen. Such a display would be more readily portable, or require minimal depth, and allow easy redeployment. Clearly this will require flexible substrates, and some options for reflective and emissive displays are being pursued today. Alternatively, some approaches have used rigid waveguides to direct light in a thin profile display which has the potential to scale to large areas. The use of flexible, polymeric waveguide materials can be envisioned to allow these large format displays to be rolled or folded into more convenient sizes when not in use. Challenges to be overcome include optical efficiency and either low loss switching materials, or fabrication of layered structures which can directly pipe light to specific pixels without active switching. Various approaches for full color can include broadband materials or the use of color conversion media at the specific pixel locations.

PHASE I: This Phase is intended to identify suitable candidate materials, and define the display system architecture in terms of light sources, resolution capabilities, and power requirements. Preliminary experimental characterization of concepts during Phase I is desirable.

PHASE II: This Phase will involve the fabrication and characterization of a flexible display prototype to demonstrate the operational characteristics of the proposed systems. The prototype device should be a minimum of 1/4 VGA (320 x 240 pixels) and may be monochrome, although color is preferable. Estimation of fabrication costs in volume.

COMMERCIAL POTENTIAL: The development of such a patterning technology will be well suited to a variety of military and commercial needs. For both professional and consumer use, the ability to have a display that requires minimal space when not being viewed would be a significant advantage over today's bulky large screen systems. In portable applications, module sizes could be significantly reduced if the display could be made more compact when not in use.

REFERENCES:
1) Veligdan, J.T., Proc. SPIE, Vol. 2462, pp. 94-101 (1995).
2) Morreale, Jay, ed., Society for Information Display International Symposium, Digest of Technical Papers, Vol. XXVI (1995).
3) World Wide Web DARPA/ETO Home Page (see High Definition Systems) , URL http://esto.sysplan.com/ESTO/

DARPA SB962-084 TITLE: Development of Novel Toners for Direct Printing of Conducting and Insulating Patterns

CATEGORY: 6.2 Exploratory Development; Electronics; Materials, Processes and Systems; and Manufacturing Science and Technology

OBJECTIVE: Demonstrate new toner materials and binders suitable for direct electrostatic printing of fine (< 5 micrometers) features that are conductive or insulating for use in microelectronics, display, or electronic packaging applications.

DESCRIPTION: Recent work (see reference 1 below) has demonstrated the feasibility of using electrodeposition techniques (e.g. laser printing) to deposit toners which can serve as in-situ lithography masks or as sacrificial layers for lift-off processing. In such applications, typical carbon-based toners are opaque enough to serve as masks, but the toner materials do not have physical properties desirable for final device structures. The ultimate potential of electrodeposition patterning will be using this technique to directly and selectively pattern conducting or insulating structures without requiring additional processing. While some toners or precursors exist with suitable properties, they are typically much larger than desired for fine patterning, and the binder materials used are not suitable for final devices. The unavailability of these materials today is the limiting factor in aggressively pursuing direct patterning by electrodeposition. This SBIR topic will include the identification and preparation of novel toner materials that can be used for direct patterning of submicron conducting or insulating features, and their demonstration and evaluation in printing appropriate structures.

PHASE I: This Phase is intended to identify suitable candidate materials, analyze the improvements necessary for direct patterning of fine features, and define suitable processing conditions for the electrodeposition process. Preliminary experimental characterization of concepts during Phase I is desirable.

PHASE II: This Phase will involve the fabrication and characterization of an operational test device to demonstrate the application of direct printing in the fabrication process. Such a demonstration should produce a device comparable to those found in commercial practice, and the relative manufacturing costs of the electrodeposition process relative to traditional processing should be quantified.

COMMERCIAL POTENTIAL: The development of such a patterning technology will be well suited to a variety of military and commercial needs. Many non-critical lithography applications could be replaced by such a process, which will require less expensive capital equipment and significantly reduce materials consumption.

REFERENCES:
1) Gleskova, H., S. Wagner, and D. S. Shen, Electron Dev. Let. 16, pp. 418-420 (1995).
2) Morreale, Jay, ed., Society for Information Display International Symposium, Digest of Technical Papers, Vol. XXVI (1995),
3) World Wide Web DARPA/ETO Home Page (see High Definition Systems), URL http://esto.sysplan.com/ESTO/

UNITED STATES SPECIAL OPERATIONS COMMAND

Proposal Submission

The United States Operations Command's (USSOCOM) missions include developing and acquiring unique special operations forces (SOF) equipment, material, supplies and services. Desired SOF operational characteristics for systems, equipments and supplies include: lightweight and micro-sized; reduced signature and low observable; built-in survivability; modular, rugged, reliable, maintainable and simplistic; operable in extremes temperature environments; water depth and atmosphere pressure proof; transportable by aircraft, ship and submarine, and deployable by airdrop; LLPI/LPD jam resistant C3I, electronic warfare capable of disruption and deception; near real-time surveillance, intelligence and mission planning; highly lethal and destructive; low energy/power requirements; and compatible with conventional force systems. USSOCOM is seeking small businesses with a strong research and development capability and understanding of the necessity for consideration of these SOF operational characteristics for systems. The topics on the following pages represent a portion of the problems encountered by SOF in fulfilling its mission.

USSOCOM invites the small business community to send proposals directly to the following address:

United States Special Operations Command
Attn: SOKO/SBIR Program, Topic No. SOCOM 96.2-00__
2408 Florida Keys Avenue
MacDill Air Force Base, Florida 33621-5316

The proposals will be distributed to the appropriate technical office(s) for evaluation. Inquires of a general nature or questions concerning the administration of the SBIR program and proposal preparation should be addressed to:

United States Special Operations Command
Attn: SOSB/ Ms. Debra A. James
7701 Tampa Point Blvd.
MacDill Air Force Base, Florida 33621-5316

USSOCOM has identified 2 technical topics for the solicitation released during FY 96 by DOD, to which small businesses may respond. The topics listed are the only topics for which proposals will be accepted. The topics were initiated by USSOCOM technical offices that manage the research and development in these areas. Scientific and technical information assistance may be requested by using the DTIC SBIR Interactive Technical Information System (SITIS).

Firms are encouraged to submit a proposal for an optional task which would be performed during the period between Phase I completion and Phase II contract award. The optional task provides the opportunity to reduce the gap between Phase I and II. The maximum amount of SBIR funding used for an USSOCOM Phase I award is $100,000. Proposals that include the option task shall not exceed $70,000 for Phase I and $30,000 for Phase I Option. Any option proposal must be submitted at the same time and place as the basic Phase I proposal and not be included in the basic Phase I proposal page limitation. The basic Phase I proposal shall be evaluated exclusive of the option task and must be proposed and priced separately. The option portion of the proposal shall not exceed 10 pages, not exceed $30,000, not exceed three months in duration, and be evaluated using the same evaluation criteria as Phase I proposals. The transition option work shall be included as an option in the Phase I contract and evaluated for USSOCOM unilateral exercise at any time after Phase I award through the conclusion of the basic Phase I contract. Exercise of any option shall be at the sole discretion of USSOCOM and shall not obligate USSOCOM to make a Phase II award.

Selection of proposals for funding is based upon technical merit and the evaluation criteria included in this solicitation. As funding is limited, USSOCOM reserves the right to select and fund only those proposals considered to be superior in overall technical quality and most critical. As a result, USSOCOM may fund more than one proposal in a specific topic area if the technical quality of the proposals is deemed superior, or it may fund no proposals in a topic area.

USSOCOM
FY 1996 SBIR TOPIC INDEX

SUBJECT/WORD INDEX TO THE SOCOM SBIR SOLICITATION

USSOCOM

FY 1996 TOPIC DESCRIPTIONS

SOCOM 96-001 TITLE: State of Battery Health Test Set for Special Operation Force Equipment Batteries

CATEGORY: Advanced Development; Energy Storage

OBJECTIVE: Develop a testing mechanism(s) that will determine the state of charge, power storage capacity, and the remaining useful life for different types of batteries used in Special Operation Force equipments.

DESCRIPTION: Many of the Special Operation Force (SOF) equipments use primary and rechargeable batteries as the power sources for operation. Operators must be absolutely certain that these critical equipments will function properly during operational missions. Without an accurate and reliable method to determine how long a specific primary of rechargeable battery will power a specific equipment (i.e., it's internal power capacity), SOF operators take extra batteries into the field to be certain that power will be available, Backup and extra batteries comprise a major weight source for operators to carry in their rucksacks. Often the operators will choose only new batteries in hopes of maximizing battery performance in the field. This causes increase operational costs as older, still useful rechargeable batteries to be neglected rather than used throughout their useful life. USSOCOM requires a battery tester, either stand-alone or integral to a battery's case, that can determine the useful life remaining in various SOF batteries. Battery chemistries of interest include common dry cells, lead acid, lithium sulfur dioxide, nickel cadmium, silver zinc, nickel metal hydride, and lithium manganese dioxide.

PHASE I: Investigate methodologies for determining the state of charge, power storage capacity, and the remaining useful life for different types of batteries used in Special Operation Force equipments. Propose a methodology(ies) for measurement for a minimum of lithium sulfur dioxide and one other battery chemistry. Application of the developed methodology to other battery chemistries is highly desired.

PHASE II: Develop, fabricate and test a state of battery health measurement system using the recommended methodology(ies). Develop a prototype system for SOF operational evaluation during this phase.

PHASE III: Expand and refine the prototype system to meet the full set of operational requirements determined during SOF operational evaluation. This will include the development of test set training, maintenance, and system documentation.

COMMERCIAL POTENTIAL: This state of battery health test set has great application to commercial markets for cellular phones, portable phones, portable computers, video cameras, and other electrical devices that use batteries.

SOCOM 96-002 TITLE: New Composite Manufacturing Processes for Special Operation Forces Maritime Craft Hulls

CATEGORY: Advanced Development; Marine Systems; Materials and Processes

OBJECTIVE: Increase the state of the art in composite manufacturing for high speed boat and other special operations craft hulls and ancillary structures to improve the craft's performance, durability, fabrication cost, and sustained operational life in the saltwater environment.

DESCRIPTION: Special Operations Forces (SOF) operate a variety of high speed boats and other water craft to perform maritime interdiction patrol and insertion/extraction missions. Composite hulls and deck structures are viable alternatives if new manufacturing methods can be developed to improve the resistance of the composite material to sustained high shock and vibration levels, and seawater. Reduction in the cost of producing the hull structure and other components and in manufacturing the boat from these components is also required.

PHASE I: Investigate a new method(s) of producing maritime components using new or existing composite materials and resins that will improve the state of the art of composite boat structure components manufacturing. Investigate feasibility of applying these new method(s) of composite manufacturing using a government furnished design for the SOF Maritime Craft to be provided after award.

PHASE II: Develop the new method(s) of producing components, and fabricate and a prototype hull section and other

composite components for the identified SOF Maritime Craft. Complete outfitting the craft per government specifications and deliver for initial developmental testing and user operational evaluation.

PHASE III: Transition the new composite manufacturing methodologies to the Navy's naval architecture and maritime craft manufacturing technology base for incorporation into present SOF craft production and future SOF Maritime Craft developments.

COMMERCIAL POTENTIAL: This technology has tremendous application in the commercial sports watercraft industry and in the power boat racing industry. Lowering manufacturing costs and improving the durability of the material will greatly improve the commercial appeal of composite material in the watercraft industry.

OSD Deputy Director of Defense Research and Engineering

Small Business Innovation Research Program

PROGRAM DESCRIPTION

The Army, Navy and Air Force acting on behalf of the Deputy Director of Defense Research & Engineering (DDDR&E) Office of Technology Transition, invite small business firms to submit proposals under these 21 OSD DDDR&E topics. Firms, with strong research and development capabilities in science or engineering in any of the topic areas described in this section and with the ability to commercialize the results are encouraged to participate. Subject to availability of funds, DDR&E will support high quality research and development proposals of innovative concepts to solve the listed defense-related scientific or engineering problems, especially those concepts that also have high potential for commercialization in the private sector.

Objectives of the DDDR&E SBIR Program include stimulating technological innovation, strengthening the role of small business in meeting DoD research and development needs, fostering and encouraging participation by minority and disadvantaged persons in technological innovation, and increasing the commercial application of DoD-supported research and development results. The DDR&E Program presented in this section strives to encourage technology transfer with a focus on advanced development projects with a high probability of commercialization success, both in the government and private sector.

DDDR&E may elect to fund several or none of the proposed approaches to the same topic. We anticipate awarding 2 to 3 Phase I contracts per topic. However, there is no commitment by the DDR&E to make any awards on any topic, to make a specific number of awards or to be responsible for any money expended by the proposer before award of a contract. Phase I will typically be $100,000, for one half-person year effort over a period not to exceed six months. Proposals should concentrate on that research and development which will significantly contribute to proving the scientific and technical feasibility of the proposed effort, the successful completion of which is a prerequisite for further DoD support in Phase II. The measure of Phase I success includes evaluations of the extent to which Phase II results would have the potential to yield a product or process of continuing importance to DoD and the private sector. Proposers are encouraged to consider whether the research and development they are proposing to DoD Components also has private sector potential, either for the proposed application or as a base for other applications. If it appears to have such potential, proposers are encouraged, on an optional basis, to obtain a contingent commitment for private follow-on funding to pursue further development of the commercial potential after the government funded research and development phases.

Phase II awards will be made subject to the availability of fund, on the basis, first, of results from the Phase I effort and second, on the scientific and technical merit of the Phase II proposal, and also based on the presence of matching funds from independent third-party investors, per the SBIR fast track (see Section 4.5). Phase II awards will typically cover 2 to 5 person-years of effort over a period generally not to exceed 24 months (subject to negotiation) and may be up to $750,000. We anticipate that approximately one-third of Phase I awards will result in Phase II projects. For Phase II, no separate solicitation will be issued and no unsolicited proposals will be accepted. Only those firms that have successfully completed their Phase I contract efforts, will be considered.

An important goal of the program is conversion of DoD-supported research and development into commercial products. Proposers are encouraged to obtain a contingent commitment for private follow-on funding prior to Phase II where it is felt that the research and development has commercial potential in the private sector.

Questions pertaining to a specific topic should be directed to the point of contact listed in each topic. Phase I proposals written in response to OSD topics in this solicitation should be submitted to the designated office and address indicated on the next page.

OSD FY96 Program
Proposal Submission

	Mailing Address	Phone Number
Topics OSD96-001 through OSD96-007:	Joyce Crisci US Army CECOM ATTN: AMSEL-AC-BID Tinton Avenue CECOM Office Building Fort Monmouth, NJ 07703-5008	(908) 427-2665
Topics OSD96-008 through OSD96-014:	Office of Naval Research ATTN: Mr. Vincent D. Schaper ONR 362 SBIR 800 North Quincy Street Arlington, VA 22217-5660	(703) 696-8528
Topic OSD96-015:	Phillips Laboratory OLAC PL/RKS (Doug Talley) 10 E Saturn Blvd Edwards AFB, CA 93524-7660	(805) 275-6174
Topic OSD96-016:	Phillips Laboratory Propulsion Laboratory OL-AC PL/RKS Attn: Cpt Scott Wierschke 10 E Saturn Blvd Edwards AFB, CA 93524	(805) 275-5623
Topic OSD96-017:	Rome Lab Attn: Margot Ashcroft 26 Electronic Parkway Rome, NY 13441-4514	(315) 330-3021 Capt B Clarke, Tech POC
Topic OSD96-018:	Rome Lab Attn: Margot Ashcroft 26 Electronic Parkway Rome, NY 13441-4514	(315) 330-3021 A Jamberdino, Tech POC
Topic OSD96-019:	Wright Laboratory Aero Propulsion and Power Directorate 1950 Fifth St, Rm 105A WL/POMX, Bldg 18 Wright-Patterson AFB OH 45433-7251	(513) 255-3428 Betty Siferd
Topic OSD96-020:	Wright Laboratory Materials Directorate 2977 P St, Ste 13 WL/MLIP, Bldg 653 Wright-Patterson AFB OH 45433-7746	(513) 255-7175 Sharon Starr
Topic OSD96-021:	Technical Transition Office SM-ALC/CN Kim Chaves 3237 Peacekeeper Way McClellan AFB, CA 95652-1056	(916) 643-1248

OSD FY96 Topic Descriptions

ARMY, Communications-Electronics Command (CECOM)

OSD96-001 TITLE: Hydrogen Supply System for Small Proton Exchange Membrane (PEM) Fuel Cell Stacks

CATEGORY: Exploratory Development

OBJECTIVE: A compact, lightweight, rechargeable hydrogen supply system is sought.

DESCRIPTION: The system will deliver clean hydrogen at rates up to 10 grams per hour and will operate over all military environments. The hydrogen quality and delivery pressure shall be compatible with the hydrogen demands of small PEM fuel cell stacks of up to 200 watts. The hydrogen delivery system shall produce 10% hydrogen, by weight, based on the system weight. The total hydrogen required will range from 10 grams to 120 grams. Requirements for safety, transportation, and reliability shall also be addressed.

PHASE I: Phase I will consist of mass and energy balances with supporting experiments. Safety, transportation, storage, human factors engineering, cost, and reliability will be analyzed during this phase.

PHASE II: Phase II will consist of prototype fabrication and test and will integrate the hydrogen system with a fuel cell stack and controls to produce a complete fuel cell power source which will be demonstrated. A specification for the hydrogen subsystem will be developed. It is anticipated that existing fuel cell stacks will be obtained for this phase and fuel cell stack development will not be part of the phase II effort.

POTENTIAL COMMERCIAL MARKET: Small Fuel Cell Power Sources are being developed by many companies for a wide variety of applications that now use batteries. These applications range from laptop computers to electric vehicles. The source of hydrogen for these systems is a key technological barrier especially in the sub kilowatt power range. The successful development of a simple rechargeable hydrogen system that produces 10% by weight hydrogen would benefit military and commercial programs and could lead to the introduction of practical fuel cell power system in both markets. Specific military use would be to replace the BA 5590 battery in missions where high power demand causes extremely short battery life.

OSD96-002 TITLE: Small Screen Display Graphics Control for Situation Awareness (SA)

CATEGORY: Advanced Development

OBJECTIVE: Battlefield Information displayed on small screens in vehicles and Command Centers generally focuses alternately on either large areas lacking resolution or small areas lacking the broad view of SA. Over-dwelling in either display mode or transitioning between modes could result in awareness suppression of vital information that is already available to the operator. The objective is to augment the current view to suggest the content of the alternate.

DESCRIPTION: The purpose of this contract effort will be to develop graphics representations of data outside the current normal view in such a manner as to accurately convey zones of vulnerability to enemy attack and zones of influence over enemy positions without over burdening the visual capacities of the operator. The software module must be able to display standard features and military symbols on map overlays for the current view together with indicators of the presence and attributes of friendly and enemy forces reflecting the alternate views. Switching from current views and back should be virtually instantaneous. Audio and flashing visual warnings for survival threatening situations are also required.

PHASE I: Initial investigations will focus on the use of 1) descriptively-coded incremental peripheral range bands (range intervals) or vector lines to identify spheres of influence beyond the image displayed, 2) descriptively coded amorphous shapes to identify spheres of influence within a macro display, 3) background display (and off but ready displays) of alternate views that could instantly replace the foreground view/overlay, and 4) audio/video alerts tied to predefined conditions or state changes, to significantly enhance the operator's battlefield environment awareness.

PHASE II: Develop a Common Module for CHS Application.

POTENTIAL COMMERCIAL MARKET: The results of this research can be adapted to any small or large screen application in which there is critical value to maintaining a simultaneous awareness of interrelated or interactive perspectives or processes. Installations having limited space or hardware availability, or needing emergency backup redundancy could benefit from this

research. (Monitor fish schools on SONAR and other vessels on surface RADAR; navigate a narrow channel and be aware of vessels entering from the opposite direction; from an aircraft, observe localized wind shear or high wind conditions while tracking a weather front; follow an automobile route mapping small screen display and be aware of dynamic traffic patterns and hazards as well as alternate routes.)

OSD96-003 TITLE: Predictive Filtering of Situation Awareness Position Information

CATEGORY: Engineering Development

OBJECTIVE: From a communication perspective, Position Awareness (target location) places the greatest demands on system bandwidth. Various approaches for minimizing the bandwidth demands of position awareness have been investigated and compared. An approach to distributing and maintaining position information using predictive filters is found to be very robust and to require very little bandwidth. This proposal is for the development of the Kalman filter algorithm for Situation Awareness Position information.

DESCRIPTION: Predictive filters are widely used to compress speech. The idea is to identify a predictable component in the speech signal which can be described by a few parameters. If the filter performs well, the bits necessary to encode the parameter values and deviations of the true signal from the predictive model will be less than that needed to encode the raw signal. The concept is simple and efficient. However, to be of any use, the process has to be optimized and the process has to be able to provide an error estimate. The Kalman filter is an optimal predictive filter for a wide class of linear processes with gaussian error statistics and is commonly used in a wide range of target tracking applications. The Kalman filter approach maintains the target state as a set of position, velocity and error values as a function of time. At a given point in time, a new position estimate is taken and an update is prepared. Bandwidth will be conserved by not sending updates if a predicted position is within position error requirements; and if maximum bandwidth allocations are exceeded. The optimum nature of the Kalman filter algorithm will guarantee minimum position error under bandwidth constraints.

PHASE I: Phase I will consist of seven parts. The contractor will (a) work with government technical staff to evaluate the bandwidth requirement for Position Awareness; (b) analyze the Kalman filter for implementation; (c) design the algorithm for optimal target tracking; (d) prepare test plan for testing; (e) document the algorithm; (f) prepare the software source code (test version) and design documents for delivery, and (g) conduct internal testing prior to final verification and evaluation, i.e., Phase II.

PHASE II: Phase II will consist of six parts. The contractor will (a) incorporate the predictive algorithm into a simulation model provided by the Government; (b) conduct computer simulations; (c) evaluate technical data; (d) depending on the test results, modify the predictive algorithm when necessary; and (e) prepare final software design documents and (f) source code for delivery.

POTENTIAL COMMERCIAL MARKET: The predictive algorithm will not be designed for particular target "signatures". The design approach will not require the target to enter plans but extracts a "plan" from the data and minimizes position information exchanges so long as the "plan" holds. When the target maneuvers, it deviates from the extracted "plan" and the position delta update rate increases momentarily and then decreases once a new stable trajectory is established. The algorithm will be designed to conserved bandwidth by not sending updates. It is envisioned that such technology will be beneficial to industries, such as: trucking, taxi, shipping, and airlines that require instantaneous knowledge of the locations of their assets. Knowing where their assets are located at any given time will allow those industries to manage them more efficiently and deploy them expeditiously to meet new business opportunities.

OSD96-004 TITLE: Extended-Mission Command and Control Platforms Utilizing Low Power Concepts In Portable Computing Environments

CATEGORY: Exploratory Development

OBJECTIVE: Currently, the Soldier System products (computers, GPS receivers, radios) being developed are limited in their operating time and mission use to twelve hours or less. This is a direct result of: 1) limited power densities for current battery technologies and 2) minimum power consumption limits for electronic components that cannot be reduced using current technologies. Highly promising work is underway in industry to achieve significant breakthroughs in electronic power consumption. This project will focus on leveraging these commercial advances that are still in the early stages of development

and advancing them to a mature state for transition to use in Soldier System products. Accelerating these industry R&D efforts is necessary to meet the ambitious goals of future Soldier System products. In the immediate future, increased mission times of twenty-four and thirty-six hours would enhance the effectiveness of this system. As a long-range goal, future mission operating times of seventy two hours or greater in the 2002 timeframe can only be achieved by investing now in low power electronic development.

This project will explore the power reduction problem from a total integrated perspective, considering all aspects of the soldier systems consuming power, including processing capabilities, communication needs (data throughput), video capture requirements, utilization of low power electronics (reducing operating voltages below 3.3V, reducing internal gate capacitance, and utilizing parallel circuits), and power management methods, with the goal of reducing power consumption by 50% to 90% over present systems.

DESCRIPTION: Propose a computer command and control subsystem (i. e., CPU with motherboard and memory, Global Positioning System (GPS) Y-code receiver, voice recognition, and/or video capture/compression devices) for prototyping and packaging as a low power device. The devices proposed should interface with industry standard PC-based systems. Develop a migration plan for insertion of these devices into existing or planned Soldier System products (Land Warrior, Lightweight Leader Computer). High-efficiency DC-DC converters should also be planned for use in this system.

PHASE I: Develop a design and fabrication plan for a computer command and control subsystem (i. e., CPU with motherboard and memory, GPS Y-code receiver, voice recognition, and/or video capture/compression devices) for prototyping during Phase II. Include in this plan modeling and simulation results validating the planned approach.

PHASE II: Fabricate a prototype computer command and control subsystem (i.e., CPU with motherboard and memory, GPS Y-code receiver, voice recognition, and/or video capture/compression devices) for incorporation in existing or planned Soldier System products (Land Warrior, Lightweight Leader Computer). The prototype should interface with existing industry standard PC-based products.

POTENTIAL COMMERCIAL MARKET: Low power computing and sensor devices (i.e., CPUs, GPS receivers) can be utilized in the commercial marketplace by both laptop computer users, as well as outdoor sporting enthusiasts (boaters, hikers, campers). Power management hardware/software can also be applied to the same devices. The marketplace for these devices numbers in the tens of thousands. There is high demand for longer operating times of twenty-four or thirty-six hours for commercial laptops. Business travelers would consider the longer operating times a boon and corporate users would enthusiastically embrace this technology.

OSD96-005 TITLE: Digital Wireless Communications

CATEGORY: Advanced Development

OBJECTIVE: Accelerate development of dual-use communications products for law enforcement, commercial, and military applications. Needed capabilities include data rates suitable to support multi-user, mobile, and secure video teleconferencing, bandwidth flexibility, handset operation across frequency bands commensurate with military and commercial applications, and small size factor for handhold application including lightweight and low cost. Innovative antenna techniques to support mobile, directive applications, including mechanically-steered stable platforms for extended range and relay applications, shall also be considered.

DESCRIPTION: Communications products (e.g., modulation techniques, digital signal processing, antenna technology, etc.) that support mobility and emerging multimedia communications, including networking standards like TCP/IP and ATM, and compatibility and interoperability with existing communications standards such as Broadband and Narrowband Code Division Multiple Access, Land Mobile Radio, Advanced Mobile Phone Service, and Global System for Mobile Communications, etc.) shall be considered. Compatibility with Cellular, Personal Communications Service (PCS), and Instrumentation Scientific Medical (ISM) frequency allocations is also required to support worldwide digital wireless communications. Satellite (PCS) and wireless LAN technology should also be considered to accomplish world wide coverage.

PHASE I: Study and recommendations report outlining detailed design methodology for achieving program objectives. Critical factors are the ability to handle multiple waveforms, frequency bands, and users in a secure mode with minimal design impact. In order to minimize production unit cost, the product should have both a tactical and commercial application such as worldwide PCS, Cellular, and ISM for operations other than war.

PHASE II: Fabrication of prototypes to support technology development. Prototypes should be of complexity suitable to determine success of meeting the stated objectives.

POTENTIAL COMMERCIAL MARKET: Military applications include a communications system suitable for worldwide deployment providing communications that will support connectivity from the foxhole to the operations commander. Law enforcement and commercial wireless vendor use is for PCS, wireless LANs, and other comm services requiring a level of security, and flexibility of services.

OSD96-006 TITLE: Lightweight Rechargeable Batteries

CATEGORY: Advanced Development

OBJECTIVE: Develop advanced rechargeable batteries which may provide decreased weight or volume, lower overall operational costs, higher rate capability, improved safety characteristics, or decreased disposal problems. There will be increased demands placed on portable power sources as the number of communications and computer devices increases in the future, particularly in connection with the future Digitized Battlefield. There may also be opportunities for hybrid systems which combine the advantages of lower-rate capability primary and rechargeable batteries with the high rate capabilities of electrochemical capacitors and high rate batteries.

DESCRIPTION: Lightweight rechargeable batteries are required in order to substantially reduce the cost of battery power during training, as well as to provide critical tactical power sources for SOF missions where recharging energy is available. Other current technologies are based on conventional lead-acid and nickel-cadmium technologies, as well as on the initial products based on lithium-ion and nickel-metal hydride technology. These latter systems are just now being introduced into military batteries. However, there is a high probability that improved versions of these technologies, as well as other advanced rechargeable batteries (Lithium-polymer, etc.), will be developed for military and commercial use when the appropriate incentives are provided. In addition to battery systems, improved materials, such as high energy density cathodes, low temperature organic and polymer electrolytes, etc., are keys to providing improved battery systems.
Examples of the types of technology developments which are desired:

- Lower weight rechargeable batteries which are capable of operating over the temperature range from -40 to +65 C.
- Lower volume rechargeable batteries with the same characteristics.
- Lightweight batteries which exhibit superior charging characteristics, such as at high rates or high temperatures.
- Rechargeable batteries which exhibit the potential for very low operational costs during training, with or without the wide temperature operational range described above.
- Potentially low cost systems which exhibit the capability to provide high power operation for short periods, even though the temperature operational range is limited.
- High energy density rechargeable batteries which are inherently safe, and which may be shipped on commercial airlines without restrictions.
- Improved materials which either allow improvements in existing systems or make new systems feasible.

PHASE I: Initial research should focus on covering the idea/materials involved with the new concept, and an initial experimental demonstration.

PHASE II: Fabrication of a sufficient number of products to provide for both cycling tests and initial demonstrations in typical applications.

POTENTIAL COMMERCIAL MARKET: Batteries such as those described above are required for a wide range of military applications, such as in communications, night-vision devices, remote sensing, vehicle starting, etc. They have the same desired characteristics in general as those desired for commercial applications for lightweight power sources, such as for cellular telephones, portable computers, camcorders, etc. Products developed under this SBIR would clearly have uses both in military and commercial telecommunications and electronics applications.

OSD96-007 TITLE: Advanced Lossless Data Compression Techniques for Portable Computing Environments

CATEGORY: Advanced Development

OBJECTIVE: To advance the state-of-the-art in high technology and moderate risk data compression techniques and transition these improved data compression techniques into existing Soldier System programs for use in portable computing environments, after reducing the technical risk. Improved data compression algorithms, coupled with improved file/message transfer protocols, will have widespread commercial use with laptop computers and remote computing (E-mail, Internet access via wireless or cellular links).

DESCRIPTION: In today's battlefield, the use of data to enhance the commander's intelligence and view of the battle is playing an ever increasing role. With the advent of the soldier as both a fighting system and live sensor under the Land Warrior concept, the data from digitized reports during an on-going battle and their subsequent transmission to rear echelon forces is becoming critical to command and control. A significant technical barrier to overcome is to reduce the amount of digital traffic over overloaded transmission links. Since it is projected that digital traffic will increase in the future, it is foreseeable that the channel capacity may not keep pace with the demand for transmitted information across the battlefield. Currently, little or no data compression is used on the battlefield when transmitting reports, textual data and database updates. This project will focus on leveraging commercial lossless data compression techniques and developing a new standard to be utilized by the Army in reducing the amount of data traffic transmitted, while still passing the same information. This project will benefit the Army tremendously by allowing the transmission of more digital information using existing tactical links in significantly less time than currently possible. Thus, a reduction in digital traffic on already overloaded communication links and networks will allow for the increased traffic demands of the 21st century battlefield.
The goal of this SBIR program is to incorporate this data compression technique coupled with improved message transfer protocols in portable computing environments, using the Soldier System platform as an initial demonstration point. This technology can readily transition to commercial laptop platforms for improved data storage, wireless connectivity and remote computing.

PHASE I: Perform a trade-off analysis of commercially available (including beta releases) lossless data compression techniques and file/message transfer protocols for portable PC platforms. This analysis should include a comparison of these techniques with current Army doctrine. Comparisons of compressed and uncompressed file sizes, along with compression and decompression times, should be included.

PHASE II: Select one or two of the most promising techniques from the Phase I trade-off analysis and incorporate this technique into a lightweight portable platform for further testing and demonstration purposes. The Government will provide the host computer platform from one of the products being developed for the Soldier System. If this platform is unavailable, a commercial laptop PC utilizing either Unix or Windows NT will be used. The exact details of the target operating system and host platform will be determined by the Government prior to the start of Phase II.

Upon the completion of Phase II, a working prototype of the data compression software incorporated into the Soldier System platform and integrated into the current Soldier System command and control applications program will be demonstrated and delivered. The command and control applications program will utilize Ada, however, the data compression and message/file transfer techniques may be coded in alternate languages if their code is pre-existing and leverages an existing commercial product. Stand-alone commercial versions of this improved data compression and file message transfer protocol software can be readily transitioned back into the commercial marketplace as an integrated software package.

POTENTIAL COMMERCIAL MARKET: The marketplace for this product is as large as the commercial PC field, since all personnel using a PC could benefit from highly compressed files for storage, transmission and eventual recall at a remote location. Improved file/message transfer protocols, coupled with the data compression, will ensure reliable receipt of data.

NAVY

OSD96-008 TITLE: Cryocoolers for Cryoelectronics

OBJECTIVE: Develop a small, efficient, affordable, and reliable cryocooler for defense electronics systems. Innovative designs for conventional refrigeration cycles, approaches using non-conventional refrigeration cycles, and systems employing new materials are explicitly encouraged.

DESCRIPTION: Electronic systems operating at temperatures significantly below room temperature, cryoelectronics, offer a wide variety of opportunities for performance improvements in speed and sensitivity while operating at lower power levels and becoming smaller in size. Semiconducting materials operate at higher speeds with lower power consumption; superconducting materials offer zero (low) resistance material for interconnects, coils, filters, switching and logic elements, and electromagnetic detectors; and magnetic materials offer giant magnetoresistance phenomena and the possibility of spin-polarized devices. The foremost issue in developing this cryoelectronics technology is the development of small, efficient, affordable reliable refrigerators (cryocoolers) which can be integrated with the electronic systems. This topic focuses on the issues of reducing costs, increasing efficiencies, and increasing the reliability of cryocoolers.

PHASE I: Develop design of cryocooler and do preliminary calculations on efficiency and affordability. Indicate plan for incorporation in specific electronic systems. Goal is to have a Mean Time Before Maintenance of greater than 3 years and a cost of less than $1000 per unit.

PHASE II: Build cryocooler and demonstrate efficiency and reliability. Develop cost estimates and marketing plan for use of cryocoolers in specific electronic systems. Goals of program should be quantifiably met.

PHASE III: Incorporate cooler into an electronic system demonstration to quantify overall system performance benefits.

COMMERCIALIZATION POTENTIAL: Development of cryocoolers will find commercial applications in the cellular communications industry (high Q superconducting filters), in high network communications (low power, high speed switches), in air traffic guidance (high resolution radar), and in computer work stations and mainframes (low power logic, memory and interconnects elements).

REFERENCES:

1. Gubser, D. U. "Cryoelectronics: The Promise and the Challenge," Proceedings of the 1995 CEC/ICMC Conference (to be published)
2. For a review of Low Temperature Electronics, see Proceedings of First International Low Temperature Electronics Conference, Cryogenics 30, (December 1990) and IEEE Trans. Electron Devices (1987) ED34(1).
3. For a review of the field of superconducting electronics see IEEE Transactions on Applied Superconductivity (June 1995,) Vol. 5, Parts I and III.
4. For a review of High Speed ICs and Systems see Eden, R.C. "Applicability of Superconducting Interconnection Technology for High speed ICs and Systems" Final Reports on DARPA BAA 90-06 Contract N0014-90-C-0217, (October, 1991 and 1992).
5. For a review of the field of magneto-electronics see Prinz, G.A. Physics Today, (April 1995) p. 58.

OSD96-009 TITLE: Displays for Avoiding Motion Sickness

OBJECTIVE: Develop and test head mounted displays (HMD) with gravity stabilization to counter motion sickness.

DESCRIPTION: Console operators in shipboard, land vehicle and airborne environments may suffer motion sickness when the vehicles are unstable while moving. The theory holds that conflict between visual orientation cues and orientation signals from the inner ear motion sensors (the vestibular apparatus) causes motion sickness. For example, in an interior room on a ship, the visual cues indicate that the room is stationary, but, as the ship pitches and rolls, the inner ear cues signal motion. If the operator viewed a gravity stabilized view in a head mounted display, visual and vestibular cues would be the same and motion sickness would be averted. As the ship moved, the orientation of the gravity vector would be directed to the display driver and the display would be altered appropriately. An alternative method of providing orientation cues may be to maintain the display screen orientation fixed in the HMD display screen, but provide a peripheral cue to orientation. Depending on the results of the first phase of testing this option may be pursued for closer examination. Companies are strongly encouraged to use existing HMDs rather than developing new ones so that the technology development can focus on testing and integration of orientation cues into the display.

PHASE I: Design proof of concept HMD and do controlled experiments in a simulator with a motion base. Test various movement sensors, filtering paradigms, display tilt modes, etc. to determine required and optimal values.

PHASE II: Conduct extensive testing in actual moving environments including ships, land vehicles, aircraft to further optimize of the movement sensors, filtering and cues. Determine characteristics appropriate to each environment tested. Test the option of allowing individual crew members to select system characteristics to accommodate variability in susceptibility to motion sickness. Demonstrate prototype technology including the HMD, head movement sensor, and demonstration software.

PHASE III: Production for sale to Navy and other government agencies.

COMMERCIAL POTENTIAL: The display would be applicable to any situation in which motion sickness has the potential of interfering with operator or passenger performance or comfort.

REFERENCES:
1. Johnston, R. and Willey, S. (1995). Proceedings of Helmet- and Head-Mounted Displays and Symbology Design Requirements. SPIE Volume 2465 (pp. 2-13). Bellingham, WA: SPIE.
2. Kollin, J. and Tidwell, M. (1995). "Optical Engineering Challenges of the Virtual Retinal Display." Proceedings of the SPIE, Volume 2537 (pp. 48-60). Bellingham, WA: SPIE.

OSD96-010 TITLE: Fiber Optic Bragg Grating Corrosion Monitoring System

OBJECTIVE: Develop a Fiber Optic Tap Bragg Grating Corrosion Monitoring system capable of detecting the occurrence of corrosion in key structural components and monitoring its evolution and severity.

DESCRIPTION: Stress-corrosion cracking and corrosion fatigue are well known to significantly reduce the life expectancy of structures. Development of a monitoring system, which can reliably and accurately detect the amount of corrosion experienced by a structure, would permit early and economical repairs to extend structure life. The main components of the sensor type solicited by this topic will be a fiber optic tap Bragg grating and a fiber coating containing an electrochemical active specie that changes one of its optical properties in the presence of corrosion byproducts.

PHASE I: Fabricate a proof of concept tap Bragg grating coated with an electrochemical active material. Monitor the amount of corrosion in a electrochemical polarization cell.

PHASE II: Develop a prototype Fiber Optic Tap Bragg Grating Corrosion Monitoring system. The optical fiber will have several sensors and the monitoring system will interrogate each sensor independently.

PHASE III: Production and integration of the sensor system into the U.S. Navy aircraft maintenance system.

COMMERCIAL POTENTIAL: A system of this nature has significant potential in the civilian aviation sector for monitoring corrosion in aging aircraft. Such a system could also monitor corrosion in bridges, pressure vessels, and in explosive environments where electrical sensor use might be hazardous.

REFERENCES:
1. Invention Disclosure, "Bragg Grating Corrosion Monitoring System," U. S. Navy Case Number 75942
2. Naval Air Warfare Center Aircraft Division, Warminster Technical Report, Fiber Optic Bragg Grating Model. NAWCADWAR-95027-4.3.
3. Perez, I. et al. "Bragg Grating Corrosion Sensor," Proceedings of the 1994 QNDE Conference. Snowmass, CO.

OSD96-011 TITLE: High Platform Speed Sonars

OBJECTIVE: Develop active or passive sonar systems effective at high platform speeds.

DESCRIPTION: Recently developed Navy technology establishes the feasibility of developing practical sonar systems effective at high platform speeds. Such systems, by allowing significantly faster wide area search rates, would benefit a variety of military and civilian applications. The Navy work indicates strong potential for canceling the dominant effect of flow noise on the response of current conformal active or passive sonar arrays for all platform speeds in deep and shallow water. Collectively, the approach is called Magneto-Acoustic Signal Conditioning (MASC). U. S. Patent 5,392,256 was recently issued to the Navy for a MASC sensor. The sensor provides an independent measure of the noise due to turbulent flow but does not interfere with the acoustic signal. As such, the MASC sensor can be used as an ideal reference for an adaptive filter that can perform flow noise cancellation. Measurements at various flow rates in a laboratory tank setting show that signal coherence increased with an increased flow rate, suggesting a 20 dB processing gain per sensor may be easily achievable. Through electronic design improvements, a benchtop prototype unit tested in air achieved an additional 30 dB noise rejection while maintaining the same bandwidth. Applied Research remains outstanding in the area of noise processing, electronic and material integration, and conformal array implementation. An issue is whether motion in the wall containing the sensor creates additional electronic field noise due to magnetic movement.

PHASE I: Design and fabricate a small MASC/conformal sonar array assembly and embed it in a Navy hydrodynamic tow body. Demonstrate acoustic interaction of the modified conformal array with respect to a fixed acoustic source at various

low frequencies in a sea test.

PHASE II: Determine the least number of sensor elements required to perform specified search tasks. For one task, design, fabricate, and test at sea a completely integrated and full scale prototype MASC/sonar system.

PHASE III: Transition into a Navy Advanced Technology Demonstration (ATD) program and into civilian applications.

COMMERCIAL POTENTIAL: The technology is relevant to any salt or brackish water acoustic measurement system limited by flow noise. Examples include: geophysical investigations; marine prospecting; underwater object search, detection, and avoidance; fish population surveys; topological surveys.

REFERENCES:

1. R. G. Kasper and A. B. Bruno, U. S. Patent 5,392,256, "Magneto-Acoustic Signal Conditioner," "Magneto-Acoustic Signal Conditioner," February 21, 1995.

2. A. B. Bruno and R. G. Kasper, United States Patent 4,848,146, "Electromagnetic Turbulent Velocimeter," July 18, 1989.

3. R. G. Kasper, A. B. Bruno, and L. Langston, "Preliminary Underwater Electromagnetic Turbulence Measurements," Naval Undersea Warfare Center (NUWC) Division, Newport (formerly Naval Underwater Systems Center) Technical Document. 8909, June 19, 1991.

4. A. B. Bruno, R. G. Kasper, and B. Towe, "Development of an Underwater Electromagnetic Velocimeter," NUWC Division, Newport Technical Document 10065, June 16, 1992.

5. McDowell, D .J., R. G. Kasper, and A. B. Bruno, "Preliminary Electro-Magnetic/Acoustic Signal Processing Techniques to Reduce Flow Noise," NUWC Detachment, New London Technical Memorandum 931088, July 28, 1993.

6. Langston, L. S. and R. G. Kasper, "Analysis of an Electromagnetic Boundary Layer Probe for Low Magnetic Reynolds Number Flows," Jour. of Fluids Eng. Vol. 115, pp. 726-731, 1993.

7. R. G. Kasper and L. S. Langston, Patent Pending, U. S. Navy Case Number 73185, "Electrode Array Electromagnetic Velocimeter," April, 1993.

8. T. Rydzaj, "Improved Electromagnetic Flow Electronics for the Magneto-Acoustic Conditioner (MASC) Sensor," NUWC Division, Newport Technical Memorandum 941097, in publication.

OSD96-012 TITLE: Rotorcraft Model Enhancements to Support Land and Sea-Based Testing and Operational Analysis

OBJECTIVE: To develop enhancements to a finite state dynamic inflow model to address rotorcraft cross coupling and vortex ring state conditions for land and sea-based operations.

DESCRIPTION: Accurate full-flight simulation models are required to support flight testing, especially in high pilot workload tasks like the rotorcraft shipboard landing scenario. Improved models for aircraft off-axis coupling and response to vortex ring flight conditions in normal or degraded flight control system status are needed to enhance routine or emergency condition training. One such model, the finite state dynamic inflow model, represents a major advance in rotorcraft simulation technology. This model allows the user to represent the radial and azimuthal inflow distribution with series approximations that are tailored to the required level of accuracy. Due to the computational efficiency and accuracy of this approach, the finite state dynamic inflow model is becoming widely used in rotorcraft simulation. However, it does not provide the ability to model wake deformation in a transient maneuver. As with other free vortex wake models, it is limited to steady state wake deformation and cannot address transient wake deformation. Dynamic wake distortion in a transient maneuver has recently been postulated as a potential cause for the lack of off-axis correlation of simulation results with flight test data. A vortex wake study has demonstrated the ability to improve correlation in a hover. A parameter identification approach has been used to capture the transient response by identifying an aerodynamic phase angle that is tuned to improve off-axis correlation with experimental data. The ability to model transient wake deformation analytically as an extension of the finite state dynamic inflow methodology would inherently address the source of off-axis correlation while providing a more computationally efficient approach than a vortex wake model and a more global and robust representation than a semi-empirical model tuned to experimental data. Dynamic wake deformation is also needed to model the vortex ring state. This state is caused by a concentration of vortex rings at the rotor during descending flight and may be predicted as a direct consequence of the dynamic wake deformation and vortex decay. The analytical basis of the proposed effort should address the full flight envelope, not just at hover.

PHASE I: Review all previous related work involving the finite state dynamic inflow model applications and limitations, rotorcraft off-axis coupling modeling and vortex ring state modeling. Develop a comprehensive plan for including wake deformation effects in a finite state dynamic inflow simulation model, including software development and comparison with free vortex wake results.

PHASE II: Develop the enhanced finite state dynamic inflow model and integrate it into a comprehensive simulation that can be used to support land and sea-based flight operations. Validate the resulting coupled simulation model against free vortex models and experimental test data for a variety of conditions. Evaluate the ability to model the vortex ring state and improve off-axis correlation to transient response with the model. Demonstrate the ability to utilize the finite state dynamic inflow with wake distortion in real-time simulation will be demonstrated.

PHASE III: The model enhancements should result in interest from the Navy, Army, Air Force Special Ops, Coast Guard, FAA, and commercial helicopter manufacturers.

COMMERCIAL POTENTIAL: The enhanced finite state dynamic inflow model, with wake distortion, can be marketed as a stand-alone product for incorporation with a variety of commercial simulation codes or can be combined with a specific comprehensive simulation code to enhance its utility and marketability.

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1. Peters, D.A., and He, C.J., "Finite State Induced Flow Models Part II, Three Dimensional Rotor Disk," Journal of Aircraft, Vol 32 #2, March-April, 1995.
2. Rosen, A. and Issur, A., "A New Unsteady Aerodynamic Model of the Coupled Rotor-Body Dynamics," 51st American Helicopter Society Annual Forum, Forth Worth, Texas, May, 1965.
3. Fletcher, Jay, "Identification of Linear Models of the UH-60 in Hover and Forward Flight," 21st European Rotorcraft Forum, St. Petersburg, Russia, Aug. 29-Sep 1, 1995.
4. Wang, Shi-Cun, "Analytical Approach to the Induced Flow of a Helicopter Rotor in Vertical Descent," Journal of American Helicopter Society, Vol. 35, #1, Jan. 1990.

OSD96-013 TITLE: Underwater Acoustic Intensity Probe

OBJECTIVE: Produce a commercially viable probe for measuring vector acoustic intensity underwater.

DESCRIPTION: The underwater acoustic intensity probe described in US Patent #5,392,258 (assigned to the US Government) serves as the basis of this topic. The intent of the topic is to take the technology from patent through prototype to development of a commercially viable version of the probe. Acoustic intensity is the time-averaged product of acoustic pressure and vector particle velocity and describes the direction and magnitude of real power flow in an acoustic field. Knowledge of the acoustic intensity can be used to trace the source of radiated sound and can be used to isolate the paths by which sound is traveling. Once the source of the radiated noise is determined and the radiation path is described, various techniques can be applied to reduce or eliminate the sound radiation. The acoustic intensity field also describes the effectiveness with which an acoustic source transfers energy to the water and is a useful tool for optimizing such sources. Conventional measurement of acoustic intensity is performed with a two-hydrophone differencing technique. This technique, because it relies on subtracting two nearly equal signals, is only effective when the signal to be studied is far above the ambient noise level and when standing waves produced by multiple reflections are absent. The intensity probe developed, demonstrated, and patented at the Naval Air Warfare Center (NAWC) Aircraft Division measures the acoustic velocity directly instead of by calculation from the pressure gradient. The direct measurement does not require subtraction to form the gradient and so is effective in far more circumstances than conventional intensity measurement. If the probe can be produced economically and coupled to a measurement system, then it should prove to be a valuable tool in fluid-borne acoustics (it is not limited to operation in water).

PHASE I: Fabricate and demonstrate a prototype intensity probe without support electronics.

PHASE II: Develop and fabricate several production prototypes. Develop test procedures for the probes. Evaluate the acoustic performance and the package integrity (for immersion, for 0°C to 70°C temperature tolerance, for normal handling shock). Prepare a production plan with versions of the probe suitable for both DoD and commercial applications. Design and fabricate an electronics system for either stand alone probe use or for connection to standard signal analyzer hardware.

PHASE III: Production of the probe and electronics system.

COMMERCIAL POTENTIAL: Potential uses of the probe include: diagnosis of noise radiation from submerged machinery; condition-based maintenance of machinery in ships, pumping stations, and power plants; location of sources of annoyance; mapping regions of man-made noise and disturbance of marine mammals and fish; and measurement of the effectiveness and directivity of underwater sound sources.

REFERENCES:
1. United States Patent #5,392,258, "Underwater Acoustic Intensity Probe," February 21, 1995

2. Gabrielson, T.B., Gardner, D. L., and Garrett, S. L., A simple neutrally buoyant sensor for direct measurement of particle velocity and intensity in water. J. Acoust. Soc. Am. 97 (4), April 1995, 2227-2237.

OSD96-014 TITLE: Man Portable Fluxgate Localizer for Magnetic Targets

OBJECTIVE: Develop a man portable, localization system for magnetic targets.

DESCRIPTION: The basis for this topic is a laboratory prototype of a magnetic localization system based on Fluxgate Gradiometer technology. The prototype was developed at the Naval Surface Warfare Center, Dahlgren Division. It requires electronic miniaturization, improved temperature stabilization, reduced power requirement, and enhanced software to serve as a man portable instrument. Most past magnetic sensor research has been directed toward making sensor systems more sensitive to enhance detection range. Many potential applications, however, would benefit more from the ability to perform closer-in standoff localization rather than from increased range. Desired localization ranges for UneXploded Ordnance (OXO) tsargets are 10 feet or grater for larger ordnance (bombs) and 5 feet or more for smaller ordnance (mortar and artillery rounds).

PHASE I: Develop and demonstrate an improved, temperature stable magnetic feedback capability and incorporate it in a reduced height sensor array.

PHASE II: Develop a fieldable prototype capable of man portable performance. The prototype should include all necessary electronics miniaturization and integration as well as improvements to the current software to provide the target's magnetic moment in addition to its location and eliminate all ghost solutions. Additional sensors may be implemented as necessary.

PHASE III: Limited production of the system customized and packaged for specific Navy programs.

COMMERCIAL POTENTIAL: The system's ability to perform standoff localization would find application in the oil industry to locate lost well heads or pipelines. The system would also be suitable for use in locating buried materials including hazardous waste, as well as remotely monitoring vehicular activity.

REFERENCES:
1. "Unique Man-portable, Five-element Fluxgate Gradiometer System" Proceedings, volume 2496 SPIE- The International Society for Optical Engineering 17-21 April 1995, pp 384-395
2. "Magnetic Dipole Localization Using the Gradient Rate Tensor Measured by a Five-axis Magnetometer with Known Velocity" Proceedings, volume 2496 SPIE- The International Society for Optical Engineering 17-21 April 1995, pp 357-367
3. "Three Squid Gradiometer", Applied Physics Letters, Volume 63, 1993, pg 403

AIR FORCE, Phillips Lab

OSD96-015 TITLE: Optical Patternation of Sprays

CATEGORY: Exploratory Development; Aerospace Propulsion and Power

OBJECTIVE: Use laser sheet illumination techniques to quantitatively measure the mass distribution in sprays

DESCRIPTION: Measurement of the mass distribution produced by a spray, or "patternation," is of primary importance in developing Air Force propulsion systems and other spray combustion applications. Typically this is measured by inserting an array of collection tubes into the spray, but this process is intrusive, slow, and can only be applied in cold flow. The Propulsion Directorate at Phillips Laboratory has been developing nonintrusive techniques to perform the same measurements using laser sheet technology. To date, technology has been developed to account for viewing perspective, laser sheet intensity variations, conditions of restricted optical access, extinction of the laser sheet, and extinction of the emitted signal by the spray. In view of the dual use applications described below, the market potential could be large if the various techniques could be optimized and combined into a commercially available instrument. Phillips Laboratory will make this technology available for development and use by small businesses.

PHASE I: Phase I will identify the optimum configuration of a system which will maximize commercial applications.

PHASE II: Phase II will develop, fabricate, and evaluate a prototype system, including user friendly interfaces for non-experts.

COMMERCIAL POTENTIAL: An optical patternation instrument would be marketable to any application utilizing spray combustion. This includes the majority of all land, air, and sea propulsion systems as well as the majority of the worldÆs energy conversion needs. Such an instrument would also be marketable to paints and coatings applications, powder technology applications, drying applications, and a large number of chemical processing applications.

REFERENCES:
1. Talley, D.G., Thamban, A.T.S., McDonell, V.G., and Samuelsen, G.S., "Laser Sheet Visualization of Spray Structure," to appear in an AIAA Progress Series Volume entitled Recent Advances in Spray Combustion, K.K. Keu, ed.
2. Talley, D.G., Verdieck, J.F., McDonell, V.G., Lee, S., and Samuelsen, G.S., "Accounting for Laser Sheet Extinction and Fluorescence Signal Attenuation in Applying PLIF to Sprays," 34th AIAA Aerospace Sciences Meeting and Exhibit, paper AIAA 96-0469, 15-18 January, 1996.

OSD96-016 TITLE: Rapid Densification of Carbon-Carbon and/or Ceramic High-Temperature/Lightweight Liquid Rocket Engine (LRE) Combustion Components

CATEGORY: Exploratory Development; Materials

OBJECTIVE: Design and fabricate selected liquid rocket engine combustion components, such as injectors, thrust chambers, and nozzles. The resulting components will be fabricated from advanced materials using state-of-the-art rapid densification techniques and be hot-fire tested at Phillips Laboratory, Edwards AFB.

DESCRIPTION: The Propulsion Directorate of Phillips Laboratory is at the forefront of infusing new materials technology into the very conservative rocket propulsion industry. The high temperature components group is developing carbon-carbon and ceramics densification techniques that will allow LRE components to be manufactured in a matter of days, instead of the several months required with current methods. These techniques are scaleable and will allow near net-shape components to be produced. All of the combustion system components within an LRE must be lightened and strengthened without a loss in engine performance if the DoD is to reach the goals set forth by the Integrated High-Payoff Rocket Propulsion Technology (IHPRPT) initiative.

PHASE I: Perform appropriate analysis and design an appropriate LRE component(s) that takes advantage of the properties of the materials outlined above. Show ability to manufacture components with the chosen materials.

PHASE II: Develop and fabricate the components(s) using rapid densification technology. The component must be suitable for hot-fire testing at Edwards AFB.

COMMERCIAL POTENTIAL: Carbon-carbon and ceramic materials have huge industrial potential in the auto, aircraft, medical and general materials industries. They are strong, lightweight, and heat resistant. They are however, very expensive. Exploitation of these rapid densification techniques will decrease the cost and manufacturing time of these materials, making them attractive for such applications as automotive engines and aircraft brakes.

REFERENCES:
1. Upadhya, K. and Hoffman, W.P. "Densification of Porous Articles by Plasma Enhanced Chemical Vapor Infiltration (PECVI)", US Pat No. 5468357
2. Mochida, I. "Direct Preparation of Mesophase Pitch from Napthalene by the Aid of HF/BF3", Chemistry Letters of the Chemical Society of Japan, 1989, p 1893-1896.

Rome Labs

OSD96-017 TITLE: Parallel Optical Memory Interconnects

CATEGORY: Exploratory Development; Electronics

OBJECTIVE: Recently, it has become evident that to meet mass data storage requirements of emerging systems and networks, optical three-dimensional memories will be required and there is currently a massive effort in optical memory development. One issue that is currently limiting the unbounded potential of these systems is the I/O bottleneck. This effort seeks to develop parallel, free space optical memory interconnects that can handle data rates on the order of Gbytes/sec and interface with

emerging memory systems.

DESCRIPTION: Technology to be developed include spatial light modulators used as page composers in optical memory schemes, micro-collimating lenses, dynamic focusing optics CCD detectors. Issues to consider include data formats and data transfer to and from a host processor.

PHASE I: During Phase I of this effort, the contractor will develop and demonstrate proof of concept for an optical interconnection device capable of I/O functions interfacing optical memory with electronic CPU.

PHASE II: Phase II will demonstrate the operation of this interconnection and investigate technical aspects of producing these interconnects.

COMMERCIAL POTENTIAL: Current and future military requirements (intelligence networks, image libraries, virtual reality training systems, etc.) and civilian requirements (large database storage, medical records and telemedicine, video on demand, digital television) ensure the dual use potential for any high bandwidth data transfer systems.

REFERENCES:

1. RL-TR-95-25, "Optical Volume Storage Interconnects", L. Domash and A. Nelson., Foster-Miller Inc. 1995.
2. RL-TR-92-127, "Active Holographic SLM for Optical Interconnects", L. Domash and J. Schwartz, Foster-Miller Inc. 1992.
3. RL-TR-94-11, "Vibration Insensitive Reconfigurable Optical Interconnects"; A. Nelson, Gozewski, and L. Domash; Foster-Miller Inc. 1994.
4. RL-TR-94-45, "Free Space Parallel Optical Memory Interconnect"; M. Derstine, J. Goodman; Optivision Inc. 1994

OSD96-018 TITLE: Optical Memories

CATEGORY: Exploratory Development; Electronics

OBJECTIVE: Rome Laboratory is investigating the use of photonic technology in advancing the state of the art in data storage. Optical memories show promise in many areas of the data storage hierarchy. Applications include:
archival storage, random access memory, read only memory, cache memory, and associative (content addressable) memory. Three dimensional optical memory offers the potential of terabit storage in volumes on the order of a cubic centimeter. High data transfer will be crucial for military applications as well as civilian uses.

DESCRIPTION: This initiative is directed towards exploiting the "optical Advantage" of storing digital data in the form of optical volume or 3-dimensionally. Concepts such as content addressable memory either numerical, textural, or image identification techniques can be implemented in memory, results isolated, and effectively provide acceleration of output speed and access time. Correlation, auto-correlation, and change detection concepts within the memory itself should also be exploited.

PHASE I: Identify and characterize candidate media, lens architectures, or beam steering concepts to provide storage capacities of 10E10-10E12 bits per cubic centimeter, or at least l0E3-10E6 discrete locations per centimeter.

PHASE II: Incorporate these concepts into a usable architecture and demonstrate feasibility via brassboard.

COMMERCIAL POTENTIAL: Imagery exploitation would be greatly enhanced by the development of faster storage devices, not to mention the benefits of terabit of data accessible at any instant. Medical data will benefit from the advancement of these technologies as well. Imagine your entire medical history available to a physician in another town should medical attention be necessary away from home. A library of X-ray files stored digitally that not only are available on demand, but, now that images are stored digitally, a computer would assist the doctor in detecting tumors earlier than would have been possible before. The development of the "Information Superhighway will hinge on the development of memory systems capable of storing more data than ever before, as well as transferring that data faster than ever before.

REFERENCES:

1. J. Ford, S. Hunter, R. Piyaket, Y. Fainman, S. Esner; "Write/Read Performance in 2 Photon 3-D Memories"; SPIE Proceedings, Photonics for Processors, Neural Networks, and Memories; Vol 2026, pp 604, July 1993.
2. D. Parthenopoulos, P. Rentzepis; "Three Dimensional Optical Storage Memory", Science 245, pp 843-845, 1989.
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Memories; Vol 2026, pp 653, July 1993.

Wright Lab

OSD96-019 TITLE: High Efficiency Cryogenic Power Conversion

CATEGORY: Exploratory Development; Aerospace Propulsion and Power

OBJECTIVE: To employ recent developments in cryogenic power conversion in a commercial demonstration of a megawatt class power convertor/motor controller that can reduce weight and volume by a factor of 10 while operating at increased efficiency and reliability. The innovative technology to be employed includes adaptation of commercial MOS-FET semiconductor switches to cryogenic conditions, commercialization of cryogenic capacitors, and commercialization of high temperature superconducting and cryogenic aluminum inductors. Small l00kW power convertors employing these conditions have already been demonstrated under cryogenic conditions and 2 kilojoule inductors have already been demonstrated using both high temperature superconductors and aluminum conductors.
None of the required components are available on-the-shelf, but all are ready to be developed to proceed to commercialization Phase III in megawatt class power convertor/motor controllers.

DESCRIPTION: Specific technology to be developed includes processing of large quantities of ceramic capacitors, demonstration of 10 kilojoule inductors and cold plate mounting and demonstration of high current MOS-FET switches at 6 to 8 times the current allowed by room temperature operation.

PHASE I: Component demonstrations of capacitors, inductors and MOS-FET switched will be conducted in Phase I. In addition, Phase I will provide a preliminary design of a megawatt class power convertor/motor controller.

PHASE II: Phase II would complete the evaluation and assessment of cryogenic capacitors and MOS-FETs. Phase II will provide the final design, fabrication and test of a megawatt class cryogenic power convertor/motor controller with a goal of less than 0.05 kg/kW.

COMMERCIAL POTENTIAL: The private sector benefit of the demonstration of a megawatt cryogenic class power convertor/motor controller is broad and would include uninterruptable power convertor systems, adjustable speed controllers for large industrial motors, static volt ampere reactive (VAR) compensators for commercial utilities, high current rectifiers for metal and electrolysis plants and power convertors and motor controllers for railroad locomotives and high speed passenger trains. The technology benefit on the military side is critical and provides enabling technology for high power convertors for deployable bare base power, mobile ground based radars, advanced airborne radar surveillance, airborne laser and high power microwave weapons and mobile drive systems for electric tanks, ships and other vehicles. Farther out technologies for which cryogenic power convertors/motor controllers will be essential include magnetically levitated and electromagnetically driven high impact test sleds and space launchers. The military systems will receive major benefit from the tremendous weight and volume reduction potential offered by cryogenic power convertor/motor controller technology at high power levels. The reduction in weight is accompanied by increased efficiency and reliability with good potential for cost reductions. The commercial sector will, of course, benefit from all the technological improvements provided by cryogenic cooling. Commercial annual market projections for the annual global market for power convertors >100kW is $200M.

REFERENCES:
1. Blanchard, R., "Designing Switch-Mode Power Convertors for Very Low Temperature Operation," Proceedings Powercon 10 (1983) D2,1-11.
2. Mueller, O., "On Resistance, Thermal Resistance and Recovery Time of Power MOSFETS at 77K," Cryogenics, Vol 29, #10, Oct 1989, pp 1006-1014.
3. Severns, R., "Superconductivity and Low-temperature Power Convertors," Powertechnics Magazine (1988) 4,p.32-34.
4. O. Mueller, "Properties of High Power Cryo - MOS-FETs," Proceedings of the 27th Power Electronics Specialists Conference (PESC-96), 24-27 June 1996, Baveno, Italy.
5. American Superconductor Corp. Publicity Release, Westborough, MA, 8 November 1995, "American Superconductor Successfully Demonstrates Commercial-Scale Prototype Power Convertor," (617-932-1122).

OSD96-020 TITLE: Smart Sensors Using Fiber-Optics and Distributed MEMS (Microelectromechanical Systems)

CATEGORY: Exploratory Development; Materials

OBJECTIVE: Develop and demonstrate the technology for connecting and multiplexing large numbers of microdevices, such as sensors and actuators for structural monitoring or smart structural control, using fiber-optic technology.

DESCRIPTION: Numerous applications of interest exist for structures, surfaces and materials whose shape, mechanical properties, or functional behavior can be altered in real-time response to changing conditions without explicit external command. Examples are:

A) Wing spars which can become stiffer in different directions depending on the direction of primary loading
B) Smart wing skins containing arrays of microdevices which can control boundary layer separation and buffet-induced vibrations at high angles of attach
C) MEMS to increase the effectiveness of flight control surface trailing edges

Key to implementation of such structures is the ability of an automated system to interconnect, address and control large numbers of distributed sensing and actuation elements. Depending on the application, these may be pressure sensors, shear stress sensors, temperature sensors, microflaps, linear actuators, miniaturized hydraulic actuator valves, or other devices. Fiber-optics technology shows promise for this application in that large numbers of devices can potentially be multiplexed along single fibers, and the fibers may be easily integrated with structures, particularly fiber-based composites. The techniques for achieving good connections between several devices and a single fiber, and for assuring effective communication with/between these devices, need to be matured.

Proposals may be targeted toward any one or all of the above application areas.

PHASE I: Develop and demonstrate the ability to connect several discrete devices along the length of an optical fiber so that communication with each device is possible.

PHASE II: Demonstrate a prototype system for gathering signals from a large number of distributed devices arranged along optical fibers, and sending signals back to individual devices in response to the collected signals. This prototype system will be suitable for use in a smart structure, flight control, aerodynamics or structural monitoring demonstration.

COMMERCIAL POTENTIAL: The maturation of this technology will allow the low-cost monitoring, and eventual smart structural control, of civil structures such as bridges and buildings, marine structures such as off-shore platforms, as well as civilian aircraft, spacecraft and other complex structural systems.

REFERENCES:
1. Mehregany, M. and Bang, C., "MEMS for Smart Structures," Proc. of SPIE Conf.Smart Struct. and Matls. Feb 26-March 3, 1995.
2. Claus, R., Sherrer, D., and Weng, A., "optically Based, Micro-Integrated Materials and Structures," Proc. of Micro-Integrated Smart Matls. and Struct. Conf., Soc. for Experimental Mechanics, Sept. 1995.
3. Jacobson, S.A. and Reynolds, W.C., "Active Control of Boundary Layer Wall Shear Stress Using Self-Learning Neural Networks," AIAA 93-3272, 1993.

Technical Transition Office

OSD96-021 TITLE: Small Lot Repair/Manufacture of Microcircuit Boards by Laser Deposition

CATEGORY: Engineering Development; Electronics

OBJECTIVE: Develop a real-time, computer controlled laser capable of the precision deposition of metal on a variety of substrates.

DESCRIPTION: Metal may be deposited on a variety of materials including plastic, glass, and ceramic by thermal breakdown of metal halide gases. The metal halides typically have a decomposition temperature ranging from 350 degrees F to 650 degrees F. It is intended that a laser be utilized to produce the required heat. The heat pattern would be localized on a microscopic

basis with a width and depth dependent upon the laser source. The localized heating would not be expected to damage the substrate material. The chemical vapor deposition and laser technology associated with this project is established. The intent will be to place the laser under real-time computer control or manual control whereby the beam may be directed to a precise location. In the case of an assembled microcircuit board, the objective would be to create new traces without disassembly. Disassembly frequently damages the components which may no longer be available. The process is also directed at the economical manufacture of small lots of new boards. The real-time computer allows data to be input and then the traces applied directly to the subtrate.
The number of passes made by the laser will determine the depth of metal deposition, trace width and pattern. The project will eliminate many of the costly and defect prone phases of microcircuit board processing. The device will also have the capability to repair its own defects.

PHASE I: Conduct a technical analysis of microcircuit boards determining the necessary unit specifications for the laser deposition device. Analysis will include definition of laser type, halide compounds to be utilized, environmental hazards, accuracy of beam control, and chamber materials and construction. An economic analysis will also be required of the cost to produce the unit, operating costs thru put and return on investment. A detailed analysis and preliminary design shall be provided of the laser deposition unit.

PHASE II: In this tasking a prototype computer controlled, laser deposition unit shall be constructed. The unit shall be capable of accommodating assembled or bare boards up to 2 feet in major dimension. The ability to repair assembled boards and to create new boards from drawings shall be demonstrated.

COMMERCIAL POTENTIAL: The production of small lots of microcircuitry boards is frequently undesirable to industry. This results in the scarcity of manufacturing sites and frequently high costs for those boards that are produced. This subject unit would eliminate the risk and setup costs associated with small lots. The unit would be adaptable to virtually any manufacturer of electronic wire boards/microcircuit boards. It is particularly significant to those organizations doing microwave or gold ceramic.

9.0 SUBMISSION FORMS AND CERTIFICATIONS

Section 9.0 contains:

Appendix A: **Proposal Cover Sheet**
Appendix A (or photocopy) must be included with each proposal submitted.

Appendix B: **Project Summary Form**
Appendix B (or photocopy) must be included with each proposal submitted. Don't include proprietary or classified information in the project summary form.

Appendix C: **Cost Proposal Outline**
A cost proposal following the format in Appendix C must be included with each proposal submitted.

Appendix D: **Fast Track Application Form**
A new DoD pilot program that provides interim funding and DoD's highest priority for Phase II award to projects that attract third party investors.

Reference A: **Proposal Receipt Notification Form**

Reference B: **DTIC Information Request Form**

Reference C: **Directory of Small Business Specialists**

Reference D: **SF 298 Report Documentation Page**

Reference E: **DoD SBIR/STTR Mailing List Form**

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PROPOSAL COVER SHEET

Failure to fill in all appropriate
spaces may cause your proposal to be disqualified

TOPIC NUMBER: ____________________

PROPOSAL TITLE: ____________________

____

FIRM NAME: ____________________

MAIL ADDRESS: ____________________

____

CITY: ____________________ STATE: ________ ZIP: ________

PROPOSED COST: ____________________ PHASE I OR II: _____ PROPOSAL PROPOSED DURATION: _____ IN MONTHS

BUSINESS CERTIFICATION:

	YES	NO
▸ Are you a small business as described in paragraph 2.2?	☐	☐
▸ Are you a minority or small disadvantaged business as defined in paragraph 2.3? (Collected for statistical purposes only)	☐	☐
▸ Are you a woman-owned small business as described in paragraph 2.4? (Collected for statistical purposes only)	☐	☐
▸ Have you submitted proposals or received awards containing a significant amount of essentially equivalent work under other DoD or federal program solicitations? If yes, list the name(s) of the agency or DoD component, submission date, and Topic Number in the spaces below.	☐	☐

____________________ ____________________

____________________ ____________________

▸ Number of employees including all affiliates (average for preceding 12 months): ____________________

PROJECT MANAGER/PRINCIPAL INVESTIGATOR	CORPORATE OFFICIAL (BUSINESS)
NAME: ____________________	NAME: ____________________
TITLE: ____________________	TITLE: ____________________
TELEPHONE: ____________________	TELEPHONE: ____________________

For any purpose other than to evaluate the proposal, this data except Appendix A and B shall not be disclosed outside the Government and shall not be duplicated, used or disclosed in whole or in part, provided that if a contract is awarded to this proposer as a result of or in connection with the submission of this data, the Government shall have the right to duplicate, use or disclose the data to the extent provided in the funding agreement. This restriction does not limit the Government's right to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained on the pages of the proposal listed on the line below.

PROPRIETARY INFORMATION: ____________________

____________________ ________ ____________________ ________

SIGNATURE OF PRINCIPAL INVESTIGATOR DATE SIGNATURE OF CORPORATE BUSINESS OFFICIAL DATE

Nothing on this page is classified or proprietary information/data

INSTRUCTIONS FOR COMPLETING APPENDIX A

AND APPENDIX B

General:

DOD Components employ automated optical devices to record SBIR proposal information. Therefore the proposal cover sheet (Appendix A) and the project summary (Appendix B) should be typed without proportional spacing using one of the following typestyles:

Courier 12,10 or 12 pitch
Courier 71 10 pitch
Elite 71
Letter Gothic 10 or 12 pitch
OCR-B 10 or 12 pitch
Pica 72 10 pitch
Prestige Elite 10 or 12 pitch
Prestige Pica 10 Pitch

Whenever a numerical value is requested type the numerical character (i.e. in "Proposed Duration" type 6 NOT six).

When typing address information use the two alphabet characters used by the Post Office for the state, DO NOT SPELL OUT THE FULL STATE NAME (i.e. type NY not New York or N.Y.).

Complete and submit the Appendix A and B forms as pages 1 and 2 of each proposal plus (4) complete copies must be submitted (see Section 6).

Carefully align the forms in the typewriter using the underlines as a guide. The forms are printed to accommodate standard typewriter spacing.

Additional forms may be obtained from your State SBIR Organization (Reference D) or:

Defense Technical Information Center
ATTN: DTIC-SBIR
8725 John J Kingman Road, Suite 0944
Ft. Belvoir, VA 22060-6218
(800) 363-7247 (800 DOD-SBIR)

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PROPOSAL COVER SHEET

Failure to fill in all appropriate
spaces may cause your proposal to be disqualified

TOPIC NUMBER: ______________________________

PROPOSAL TITLE: ____

____

FIRM NAME: ____

PHASE I or II PROPOSAL: __________

Technical Abstract (Limit your abstract to 200 words with no classified or proprietary information/data.)

Anticipated Benefits/Potential Commercial Applications of the Research or Development.

List a maximum of 8 Key Words that describe the Project.

______________________________ ______________________________

______________________________ ______________________________

______________________________ ______________________________

______________________________ ______________________________

Nothing on this page is classified or proprietary information/data

INSTRUCTIONS FOR COMPLETING APPENDIX A

AND APPENDIX B

General:

DOD Components employ automated optical devices to record SBIR proposal information. Therefore the proposal cover sheet (Appendix A) and the project summary (Appendix B) should be typed without proportional spacing using one of the following typestyles:

Courier 12,10 or 12 pitch
Courier 71 10 pitch
Elite 71
Letter Gothic 10 or 12 pitch
OCR-B 10 or 12 pitch
Pica 72 10 pitch
Prestige Elite 10 or 12 pitch
Prestige Pica 10 Pitch

Whenever a numerical value is requested type the numerical character (i.e. in "Proposed Duration" type 6 NOT six).

When typing address information use the two alphabet characters used by the Post Office for the state, DO NOT SPELL OUT THE FULL STATE NAME (i.e. type NY not New York or N.Y.).

Complete and submit the Appendix A and B forms as pages 1 and 2 of each proposal plus (4) complete copies must be submitted (see Section 6).

Carefully align the forms in the typewriter using the underlines as a guide. The forms are printed to accommodate standard typewriter spacing.

Additional forms may be obtained from your State SBIR Organization (Reference D) or:

Defense Technical Information Center
ATTN: DTIC-SBIR
8725 John J Kingman Road, Suite 0944
Ft. Belvoir, VA 22060-6218
(800) 363-7247 (800 DOD-SBIR)

U.S. DEPARTMENT OF DEFENSE
SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
COST PROPOSAL

Background:

The following items, as appropriate, should be included in proposals responsive to the DoD Solicitation Brochure.

Cost Breakdown Items (in this order, as appropriate):

1. Name of offeror
2. Home office address
3. Location where work will be performed
4. Title of proposed effort
5. Topic number and topic title from DoD Solicitation Brochure
6. Total dollar amount of the proposal
7. Direct material costs
   a. Purchased parts (dollars)
   b. Subcontracted items (dollars)
   c. Other
      (1) Raw material (dollars)
      (2) Your standard commercial items (dollars)
      (3) Interdivisional transfers (at other than cost dollars)
   d. Total direct material (dollars)
8. Material overhead (rate_____%) x total direct material = dollars
9. Direct labor (specify)
   a. Type of labor, estimated hours, rate per hour and dollar cost for each type
   b. Total estimated direct labor (dollars)
10. Labor overhead
    a. Identify overhead rate, the hour base and dollar cost
    b. Total estimated labor overhead (dollars)
11. Special testing (include field work at government installations)
    a. Provide dollar cost for each item of special testing
    b. Estimated total special testing (dollars)
12. Special equipment
    a. If direct charge, specify each item and cost of each
    b. Estimated total special equipment (dollars)
13. Travel (if direct charge)
    a. Transportation (detailed breakdown and dollars)
    b. Per diem or subsistence (details and dollars)
    c. Estimated total travel (dollars)
14. Consultants
    a. Identify each, with purpose, and dollar rates
    b. Total estimated consultants costs (dollars)
15. Other direct costs (specify)
    a. Total estimated direct cost and overhead (dollars)
16. General and administrative expense
    a. Percentage rate applied
    b. Total estimated cost of G&A expense (dollars)
17. Royalties (specify)
    a. Estimated cost (dollars)
18. Fee or profit (dollars
19. Total estimate cost and fee or profit (dollars)
20. The cost breakdown portion of a proposal must be signed by a responsible official, and the person signing must have typed name and title and date of signature must be indicated.
21. On the following items offeror must provide a yes or no answer to each question.
    a. Has any executive agency of the United State Government performed any review of your accounts or records in connection with any other government prime contract or subcontract within the past twelve months? If yes, provide the name and address of the reviewing office, name of the individual and telephone extension.
    b. Will you require the use of any government property in the performance of this proposal? If yes, identify.
    c. Do you require government contract financing to perform this proposed contract? If yes, then specify type as advanced payments or progress payments.
22. Type of contract proposed, either cost-plus-fixed-fee or firm-fixed price.

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
FAST TRACK APPLICATION FORM

Failure to fill in all appropriate spaces may cause your application to be disqualified

FAST TRACK PROGRAM QUALIFICATIONS (see Section 4.5 of the solicitation for detailed explanation)

To qualify for the SBIR Fast-Track, a company must submit the following items, within 120 days after the start of its Phase I project, to the same address the company would send its Phase II proposal (see back):

(1) This application form, completed (please also send a copy to OSD SBIR -- see back);
(2) A commitment letter from an independent third-party investor indicating that the third-party investor will match both interim and Phase II SBIR funding, in cash, at the matching rate noted below (under Business Certification);
(3) A concise statement of work for the Interim SBIR effort (if an interim option was not negotiated on the Phase I contract) -- under 4 pages in length;
(4) A concise report on the status of the Phase I project (if required by the DoD component that is funding the project) -- under 4 pages in length;

In addition:

(1) The company must submit its Phase II proposal no later than 30 days prior to completion of its Phase I project (unless a different deadline for submission of fast-track Phase II proposals is specified in the Phase II proposal instructions of the sponsoring DoD component).
(2) If the company receives an interim and/or Phase II SBIR award from DoD, its matching funds must arrive before corresponding installments of SBIR funds are released (see Section 4.5 for explanation)

TOPIC #: ________________ CONTRACT #: ______________________________ PHASE I COMPLETION DATE: ______________

PHASE I TITLE: ____

____

FIRM NAME: ____

MAIL ADDRESS: ____

____

CITY: ____ STATE: __________ ZIP: ____________

BUSINESS CERTIFICATION:

	YES	NO	MATCHING RATE
▸ Do you have 10 or fewer employees and have never received a Phase II SBIR award from the federal government (including DoD)? (If YES, the minimum Third Party matching rate is 25 cents for every SBIR dollar)	☐	☐	25¢:$1 ☐
▸ Have you received 5 or more Phase II SBIR awards from the federal government (including DoD)? (If YES, the minimum Third Party matching rate is $1 for every SBIR dollar)	☐	☐	$1:$1 ☐
If you answered NO to both questions, the minimum Third Party matching rate is 50 cents for every SBIR dollar.			50¢:$1 ☐

DOD SBIR AGENCY: __________________________ THIRD PARTY: __________________________

PROPOSED INTERIM COST: ____________________ 3RD PARTY INTERIM FUNDING: ____________________

PROPOSED PHASE II COST: ____________________ 3RD PARTY PHASE II FUNDING: ____________________

FIRM CORPORATE OFFICIAL

NAME: ______________________________________

TITLE: ______________________________________

TELEPHONE: __________________________________

THIRD PARTY CORPORATE OFFICIAL

NAME: ______________________________________

TITLE: ______________________________________

TELEPHONE: __________________________________

______________________________ __________
SIGNATURE OF FIRM CORPORATE OFFICIAL DATE

______________________________ __________
SIGNATURE OF THIRD PARTY CORPORATE OFFICIAL DATE

Nothing on this page is classified or proprietary information/data

INSTRUCTIONS FOR COMPLETING APPENDIX D

General:

The Fast Track Application Form (Appendix D) should be typed in either a 10 or 12 characters per inch font.

Carefully align the forms in the typewriter using the underlines as a guide.

When typing address information use the two alphabet characters used by the Post Office for the state (i.e. type NY not New York).

Submission:

Submit all items to the same address you would send your Phase II proposal. This will be listed in the Phase II proposal instructions sent to you at the start of your Phase I project. (If you do not yet have the Phase II proposal instructions, please contact your DoD contracting officer.)

Also, please send a copy of this application form, when completed, to OSD SBIR, 3061 Defense Pentagon, Room 2A338, Washington, DC 20301-3061. Do not submit other items to OSD SBIR.

Request for Copies:

Additional forms may be obtained from your State SBIR Organization (Reference D) or:

Defense Technical Information Center
ATTN: DTIC-SBIR
8725 John J Kingman Road, Suite 0944
Ft. Belvoir, VA 22060-6218
(800) 363-7247 (800 DOD-SBIR)

TO: ____
Fill in firm's name and mailing address

SUBJECT: SBIR Solicitation No. 96.2
Topic No. ____________
Fill in Topic No.

This is to notify you that your proposal in response to the subject solicitation and topic number has been received by

____
Fill in name of organization to which you will send your proposal.

______________________________ ____________
Signature by receiving organization Date

To: SBIR Participants

SMALL BUSINESS INNOVATION RESEARCH PROGRAM REQUEST FOR DTIC SERVICES

For assistance in the preparation of informed proposals addressing the topics presented in the DoD SBIR Program Solicitation, you are encouraged to request annotated bibliographies of technical reports from the Defense Technical Information Center (DTIC). The cited reports cover selected prior DoD-funded work in related areas. Reasonable numbers of these reports may be obtained at no cost from DTIC under the SBIR Program. You will also receive information on related work-in-progress, and references to other information resources.

Complete the request form, fold, stamp and mail. Please bear in mind that significant mailing delays can occur, please order early.

DTIC authorization to provide this service expires July 5, 1996, the DoD SBIR Program Solicitation No. 96.2 closing date.

REQUESTER____
Name

ORGANIZATION NAME____

ADDRESS____
Street

________________________________ PHONE____________________
City State Zip Code Area Code/Number

Send technical reports bibliographies on the following SBIR topics:

TOPIC NUMBER	TOPIC NUMBER		TOPIC NUMBER	TOPIC NUMBER
1________	6________		11________	16________
2________	7________	*PLEASE TYPE OR PRINT IN THE*	12________	17________
3________	8________	*ORDER TOPICS APPEAR IN THE*	13________	18________
4________	9________	*SOLICITATION*	14________	19________
5________	10________		15________	20________

Company Status: I confirm that the business identified above meets the SBIR qualification criteria presented in Section 2.2 of the DoD Program Solicitation.

This is our first request during the current solicitation: yes____no____.

____
Signature of Requester

========================FOLD HERE========================

STAMP

Return Address

Defense Technical Information Center
ATTN: SBIR
8725 John J Kingman Road, Suite 0944
Ft. Belvoir, VA 22060-6218

========================FOLD HERE========================

Associate Directors of Small Business assigned at Defense Contract Management Districts (DCMD) and Defense Contract Management Area Operations (DCMAO):

DCMD WEST
ATTN: Renee Deavens
222 N. Sepulveda Blvd., Suite 1107
El Segundo, CA 90245-4394
(800) 233-6521 (Toll Free CA Only)
(800) 624-7372 (Toll Free-AK,HI,ID,MT,NV,OR,WA)
(310) 335-3260
(310) 335-4443 (FAX)

DCMAO San Francisco
ATTN: Joan Fosbery
1265 Borregas Ave.
Sunnyvale, CA 94089
(408) 541-7042

DCMAO San Diego
ATTN: Marvie Bowlin
7675 Dagget Street, Suite 100
San Diego, CA 92111-2241
(619) 637-4922

DCMAO Seattle
ATTN: Alice Toms
3009 112th Ave., NE, Suite 200
Bellvue, WA 98004-8019
(206) 889-7317/7318

DCMAO Santa Ana
ATTN: Laura Robello
34 Civic Center Plaza, PO Box C-12700
Santa Ana, CA 92172-2700
(714) 836-2913 (ext. 659 or 661)

DCMAO Van Nuys
ATTN: Dianne Thompson
6230 Van Nuys Boulevard
Van Nuys, CA 91401-2713
(818) 904-6158 (ext. 201)

DCMAO St. Louis
ATTN: William Wilkins
1222 Spruce Street
St. Louis, MO 63103-2811
(314) 331-5392
(800) 325-3419

DCMAO Phoenix
ATTN: Clarence Fouse
The Monroe School Building
215 N. 7th Street
Phoenix, AZ 85034-1012
(602) 379-6170 (ext 231 or 229)

DCMAO Chicago
ATTN: Norma Thorpe
O'Hare International Airport
10601 W. Higgins Road, PO Box 66911
Chicago, IL 60666-0911
(312) 825-6021

DCMAO Denver
ATTN: Robert Sever
Orchard Place 2, Suite 200
5975 Greenwood Plaza Blvd.
Englewood, CO 80110-4715
(303) 843-4381
(800) 722-8975

DCMAO Twin Cities
ATTN: Otto Murry
3001 Metro Drive, Suite 200
Bloomington, MN 55425-1573
(612) 335-2003

DCMAO Wichita
ATTN: George Luckman
U.S. Courthouse Suite D-34
401 N. Market Street
Wichita, KS 67202-2095
(316) 269-7137

DCMD NORTHEAST
ATTN: John McDonough
495 Summer Street, 8th Floor
Boston, MA 02210-2184
(800) 321-1861
(617) 753-4317/4318
(617) 753-3174 (FAX)

DCMAO Boston
ATTN: Philip Varney
495 Summer Street
Boston, MA 02210-2184
(617) 451-4108/4109/4110

DCMAO Cleveland
ATTN: Herman Peaks
1240 East 9th Street
Cleveland, OH 44199-2064
(216) 522-5446

DCMAO Dayton
ATTN: Betty Adams
Gentile Station
1001 Hamilton Street
Dayton, OH 45444-5300
(513) 296-5150

DCMAO Detroit
ATTN: David Boyd
905 McNamara Federal Bldg, 477 Michigan Ave.
Detroit, MI 48226-2506
(313) 226-5180

DCMAO Garden City
ATTN: Eileen Kelly
605 Stewart Avenue
Garden City, NY 11530-4761
(516) 228-5722

DCMAO Grand Rapids
ATTN: Kay Hamilton
678 Front Street, NW
Grand Rapids, MI 49504-5352
(616) 456-2620

DCMAO Hartford
ATTN: Frank Prater
130 Darlin Street
E. Hartford, CT 06108-3234
(203) 291-7705/7715

DCMAO Indianapolis
ATTN: Robert Staton
Building 1
Fort Benjamin Harrison, IN 46249-5701
(317) 542-2015

DCMAO New York
ATTN: John Castellane
207 New York Avenue
Staten Island, NY 10305-5013
(718) 390-1016

DCMAO Philadelphia
ATTN: Julia Graciano
2800 S. 20th Street, PO Box 7699
Philadelphia, PA 19101-7478
(215) 737-5818

DCMAO Pittsburgh
ATTN: Rich Spanard
1000 Liberty Avenue
Pittsburgh, PA 15222-4190
(412) 644-5926

DCMAO Reading
ATTN: Thomas Knudsen
1125 Berkshire Blvd., Suite 160
Reading, PA 19610-1249
(215) 320-5012

DCMAO Springfield
ATTN: Sylvia Liggins
955 South Springfield Ave.
Springfield, NJ 07081-3170
(201) 564-8343

DCMAO Stratford
ATTN: Otis Wade
550 Main Street
Stratford, CT 06497-7574
(203) 385-4416

DCMAO Syracuse
ATTN: Ralph Vinciguerra
615 Erie Boulevard, West
Syracuse, NY 13204-2408
(315) 448-7897

DCMD SOUTH
ATTN: Howard Head, Jr.
805 Walker Street
Marietta, GA 30060-2789
(800) 551-7801 (Toll Free-GA)
(800) 331-6415 (Nationwide)
(404) 590-6196
(404) 590-2612 (FAX)

DCMAO Atlanta
ATTN: Sandra Scanlon
805 Walker Street
Marietta, GA 30060-2789
(404) 590-6197
(404) 590-2110 (FAX)

DCMAO Baltimore
ATTN: Gregory W. Prouty
200 Towsontown Blvd.
Towson, MD 21204-5299
(410) 339-4809
(410) 339-4990 (FAX)

DCMAO Birmingham
ATTN: Lola Alexander
2121 Eight Avenue, N., Suite 104
Birmingham, AL 35203-2376
(205) 226-4304
(205) 251-5325 (FAX)

DCMAO Dallas
ATTN: Jerome Anderson
1200 Main Street, Room 640
PO Box 50500
Dallas, TX 75202-4399
(214) 670-9205
(214) 573-2182 (FAX)

DCMAO Orlando
ATTN: Victor Irizarry
3555 Maguire Boulevard
Orlando, FL 32803-3726
(407) 228-5113/5260
(407) 228-5312 (FAX)

DCMAO San Antonio
ATTN: Thomas Bauml
615 E. Houston Street, PO Box 1040
San Antonio, TX 78294-1040
(210) 229-4650
(210) 229-6092 (FAX)

DCDM INTERNATIONAL
DCMAO Puerto Rico
ATTN: Orlando Coriano
209 Chapel Drive
Navy Security Group Activity
Sabana Seca, PR 00952
(809) 795-3202
(809) 784-2011 (FAX)

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (*Leave Blank*)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED

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